State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Aquatic Resources
Honolulu, Hawaii 96813

September 22, 2006

Board of Land and
Natural Resources
Honolulu, Hawaii

REQUEST FOR AUTHORIZATION TO ISSUE ONE NORTHWESTERN HAWAIIAN ISLANDS (NWHI) STATE MARINE REFUGE RESEARCH, MONITORING AND EDUCATION PERMIT TO DR. RUSSELL BRAINARD OF THE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), FOR ACTIVITIES UNDER THE CENSUS OF CORAL REEF ECOSYSTEMS (CReefs) PROJECT, VALID FROM EARLY OCTOBER THROUGH EARLY NOVEMBER IN 2006

The Division of Aquatic Resources (DAR) hereby submits a request for your authorization to issue a NWHI Access and Activity Permit to Applicant Dr. Russell Brainard of NOAA, Pacific Islands Fisheries Science Center, Coral Reef Ecosystem Division (CRED). The Research, Monitoring and Education Permit, as described below, will allow activities to occur in the NWHI State Marine Refuge (0-3 miles) waters surrounding the French Frigate Shoals only.

The activities covered under this permit will occur from early October 2006 through early November 2006 for about twenty-three (23) days with approximately fifteen (15) consecutive days spent at French Frigate Shoals for collection/extraction activities. Cruise and support will be provided from the NOAA Ship *Oscar Elton Sette*.

The *Sette* has received and maintained a valid permit issued by the above-titled Department with the Board's authorization (Permit # DLNR.NWHI06S001). This permit does cover the period of the proposed activities herein described below.

INTENDED ACTIVITIES:

Applicant is proposing entry into the State NWHI Marine Refuge aboard the NOAA vessel *Sette* for the purpose of traveling to French Frigate Shoals (FFS) and spending approximately 15 consecutive days extracting living and non-living marine resources from State waters for the Census of Coral Reef Ecosystems (Creefs) Project. This is part of the overarching international project entitled "Census of Marine Life" (CoML), which is supported by governmental and non-governmental agencies from over 73 nations. Applicant proposes using a wide range of extraction and collection gears and activities to target a wide range of species across all marine plant divisions and all marine invertebrate phyla.

Please see Appendix I for Applicant's application.

While some DAR staff has raised significant concerns regarding the proposed activities, DAR is prepared to support the Applicant's amended permit request assuming they follow ALL special conditions outlined and conform to a revised program of activities as outlined below.

REVIEW PROCESS:

The preliminary permit application was received by the DAR on July 7, 2006. It was sent out for review and comment to the following scientific entities thereafter: DAR staff (5), Division of Forestry and Wildlife, Historic Preservation Division, Northwestern Hawaiian Islands Marine National Monument, U.S. Fish and Wildlife Service. Native Hawaiians from different agencies and organizations, including the Office of Hawaiian Affairs, UH Center for Hawaiian Studies, and Kaho'olawe Island Reserve Commission, were also consulted.

Scientific Reviews:

In July, DAR staff reviewed the application and found it to be both deficient in necessary information and of concern regarding the large numbers of organisms being targeted along with the range and amount of protected habitat being impacted. On July 14, 2006 a meeting was held at DAR consisting of the Applicant and assistants, DAR staff, USFWS Ecological Services and NOAA NWHI Reserve staff to discuss the CoML Cruise, its goals, methods, and concerns regarding the draft permit application. The Applicant agreed to revise their permit and re-submit it for consideration. A second consultation meeting was held with the Applicant, DAR staff and representatives of both the USFWS and the NOAA NWHI Reserve, along with representatives of KAHEA and Environmental Defense on September 1, 2006 at the NOAA CRED facility to discuss concerns regarding the draft application and its revision. By that time, DAR staff had conducted a thorough review of the original draft permit application and had found it to be of strong concern.

The final permit application was logged in as being received by the DAR on September 11, 2006. Due to the late submission, only DAR staff (1 staff coral reef biologist, 2 marine mammal/sea turtle specialists) has reviewed the final permit application and their comments are incorporated into the materials below.

Several reviewers from our staff and outside have responded and raised the following general issues in regard to both this application and the earlier preliminary application:

- Volume and Intensity of Extraction: A wide variety of organisms are being targeted in numbers beyond that necessary for description of a new species or new record. Targeting of cryptic, sessile and subsurface organisms entails significant habitat disturbance.

- Applicant is not specifically defining the species to be targeted, resulting in a "blanket" approach towards collection incompatible with the State NWHI Refuge. Complete collection table is necessary as to what species, or at least genera, the Applicant proposes to collect along with firm target numbers. Applicant should clearly identify mechanisms

to eliminate bycatch concerns and over-collection of target species. The collection methods and sample numbers should also be identified.

- Algae Collection: More information would be helpful as to what species likely to encounter and what species already collected on previous cruises. Will these collections be duplicative?

Staff also raised questions regarding the educational components – the outreach program – in the application. The foremost concerns are the potentially commercial use of the products from the program, additional in-water activities not identified in the permit application, and how this program is related to the CReef research activities.

Cultural Reviews:

DAR Staff called for a meeting of the Native Hawaiian Cultural Working Group (CWG) held jointly by the three NWHI Co-Trustees on September 5, 2006, at the University of Hawaii at Manoa, Center for Hawaiian Studies. The preliminary version of this application was provided to the group members at that time for their review and comments, and was also a topic of discussion. Some of the group members had previously received a copy of the application through our e-mail distribution listing. The Principal Investigator on the application, Dr. Russell Brainard, was in attendance and provided the working group with an overview of his application and answered questions from the group.

An enthusiastic discussion ensued, and CWG time constraints necessitated ending the conversation before resolution was achieved as to the CWG's recommendation on the permit's status. No recommendations on this permit application were achieved by the CWG. However, a host of concerns and reservations were raised, many specific to this application, and several that are more broadly reaching to all permits for the NWHI. The following is a summary of the issues raised in the meeting concerning this particular permit application:

- There was general concern about the international aspects of this application. How does this benefit Hawaii? If great interest is generated globally will it not encourage more people to want to go to the NWHI? We do not want to encourage people who do not respect the integrity of the place to go, just for the sake of going.

- It was shared that from the Hawaiian point of view, the way we know about evolution is from generations of observation, not from going into ocean to take organisms out.

- Submersible structures should not be allowed in the project.

- Sampling and collecting methods should show self restraint and take only as needed.

- The project needs to demonstrate more commitment to processing all of the samples they are proposing to collect.

- The project needs to demonstrate a commitment to keeping the collections, as resources invested in Hawaii. It was shared that we feel we are sending away a part of who we are when we send samples away. Having samples here gives you sense of place, gives familiarity with area—that is a valuable experience for researchers. In order to study them, scientists should be coming here to study them. In addition, Hawaii should be the center of expertise in all of this research; we should not be sending it away. The Bishop Museum should become the center of marine resources for the archipelago, especially in terms of maintaining collections from these types of cruises.

- This is a large project, with potentially large implications – especially if new species are discovered, which will necessitate additional research. Given the scope of this project, more time should be given to deliberations. The work has further reaching implications than the group has had time to explore and consider.

- There is no explicit cultural component to this research – a failing more of our research institutions. However we should consider how to balance scientific endeavors with cultural practices.

- All permittees should be required to go through a cultural orientation, so they are aware of the context of their research. There is a need for the development of materials, video, etc. so people can understand the importance of area.

- There needs to be some sort of baseline to establish what kind of impact this research is having on the species collected and overall environment.

- None of the research or species collected should be used in anyway for profit. All aspects of the research should go to the benefit of the NWHI.

- More time is needed to deliberate this permit.

Given the tight timeframe for review and comment, DAR and Monument staff followed up with individual members of the CWG after the meeting to obtain additional comments and attempt to understand if there was a consensus amongst the group. Again, they showed significant concerns on the same issues as discussed in the meeting. When some of them would give support of the application with reservations, others refrained from making a call.

APPLICANT RESPONSE:

As of Sept. 11, 2006, DAR staff had received and logged in a revised permit application with support materials from the Applicant in response to the questions and comments raised during the September 1 consultation.

It should be noted that Applicant has modified the proposal from its original draft version to eliminate collection or impact to live coral. The Applicant has prepared a modified gear/method/ collection table based on staff and agency requests.

In summary, the Applicant has agreed to remove the coral species collections and has attached a new table to this effect. The Applicant has provided graphics summarizing the sites where the various extraction and collection activities are proposed to take place (see Appendix I, Application at pp. 23, 24).

Per staff requests, the Applicant has submitted the following information necessary for the review of the Application:

- List of known species from FFS,
- Planned Collection/Extraction Sites at FFS, and
- Revised Gear/Method and Collection narratives,

In addition, there are no plans at this time for a State Trustee representative to be aboard this cruise, though representatives of both the USFWS and the NOAA NWHI Reserve will be.

On the Outreach Program issue, Applicant informed us on September 12, 2006 that the program is needed in order to help provide the public with greater knowledge of these understudied/under celebrated species. NOAA would prefer that the outreach work could reach a broader audience through a form such as National Geographic and it was agreed that this could be pursued further at a later date, with permission from the management agencies. The program will be implemented with the following in place:

- all photos will be a part of the scientific dataset;
- the data will be scientific information available for use by NOAA/USFWS, as a public trust;
- The photographer is willing to not publish or sell her work until she has permission from the management agencies if this is what they prefer;
- The photographer will be taking photos of what the scientists collect and nothing will be collected solely for photographic purposes.

ADDITIONAL AMENDMENTS OF APPLICATION:

On September 11, 2006, Applicant re-submitted a revised permit application with more complete information regarding the proposed collection activities, gear, number of collections planned, and other expedition parameters. Major changes included:

1. Removal of requests to conduct live coral sampling at FFS.

2. Revised list of chemicals to be used aboard the NOAA vessel *Oscar Sette* for killing and preservation of organisms collected.

3. Modification of the Artificial Reef Matrix Structure (ARMS) arrays. DAR staff has expressed support for this specific aspect of the expedition relative to its direct relationship to resource management.

REMAINING STAFF QUESTIONS REGARDING REVISED APPLICATION:

1. The Applicant lists Maro Reef as an alternative to French Frigate Shoals (FFS) on their proposal, yet provides no information regarding proposed activities or alterations to proposed activities to be conducted at Maro Reef. DAR has NOT reviewed this proposal relative to State protected resources at Maro. Clearly many of the shallow water /inter-tidal habitats listed in the FFS proposal are only found (if at all) within State waters at Maro. In addition, the *Oscar Sette* does not have a valid State permit for Maro Reef. RECOMMENDATION: NO activities be allowed within State waters at Maro Reef without a revised proposal specifically targeting activities at Maro Reef submitted to DAR for review and comment prior to being submitted to the Land Board.

2. The Applicant had also raised the possibility of conducting this work at either Johnston Atoll or Kingman Reef. If this work can be done elsewhere, other than the State's no-take NWHI refuge, it's hard to understand the need to allow this activity at this time within the State's refuge.

3. The Applicant lists a number of assistants who previously were listed as participating due to their expertise in extraction/classification of targeted species. Some of these targeted species (example: take of live coral) have now been removed from the proposal – if these people are still participating as assistants, is it clear that they are NOT conducting the activities that were originally proposed?

4. The "Rubble" Extraction method is a take of live rock under State law (§13-95-71), in addition to destruction of habitat as protected within the NWHI State Refuge. Such a method has been conducted repetitively in the past by CRED and others at FFS and its need is questionable for many of the FFS habitats targeted given pre-existing data from previous efforts extending back to the 1990s.

5. There appear to be a number of individuals listed on the permit application whose primary role is outreach, yet no outreach component is described. This suggests that if a State permit is issued, no in-water or resource interactive activities will take place in support of an outreach effort.

6. Under information provided by the Applicant regarding "Rubble" (Live Rock) Extraction, the Applicant proposes breaking apart Live Rock, and then exposing the Live Rock to "dilute formalin" (a lethal chemical); followed by reintroduction of the chemically-killed Live Rock back onto the reef. This would appear to violate a number of State laws relating to take of Live Rock (HAR §13-95-71), use of chemicals to take marine organisms (HRS §188-23), and introduction of chemicals into State waters (HRS §342D-50).

7. No justification is provided by the Applicant for the need to conduct lipid extractions relative to sampling efforts on protected resources from the NWHI.

8. Algal collections as targeted by the Applicant will result in a considerably large take of live rock and organisms throughout all habitats. Algae has been extensively surveyed at French Frigate Shoals, with targeted efforts extending back to over fifteen years. Recommendation: No sampling should occur in habitat types already sampled frequently by the CRED monitoring program.

STAFF OPINION:

DAR staff is of the opinion that the Applicant has properly addressed the reviewers' concerns regarding some of the proposed actions, but has NOT adequately addressed concerns regarding all proposed actions. Remaining concerns of some DAR staff include:

1. Many of the Applicant's proposed activities and gear continue to be non-selective relative to their extraction and substrate impacts on fully-protected resources, species and habitat within the no-take State waters at French Frigate Shoals (FFS). In particular, the use of dredging (identified as "scoop" by the Applicant[1]); use of lobster traps; and cryptofaunal collection, "rubble" brushing, and especially "rubble" extraction (all targeting "rubble" and "dead coral colonies" which under State law are most likely "live rock" and fully protected), all pose concerns relative to irreplaceable habitat loss and destruction. Specifically sampling in, on, and around the large table (*Acropora*) coral assemblages should NOT be allowed given previous sampling efforts dating back to the 1990's, and the fragility of these unique resources (which according to the Applicant are not the primary target habitat).

2. The wide variety of extractive activities to be conducted daily for fifteen straight days by a large number of personnel and gear within the State lagoonal waters at French Frigate Shoals poses an unacceptable risk to the critical habitat of the endangered Hawaiian Monk Seal and the threatened Hawaiian Green Sea Turtle, which make special use of this atoll. The low-lying sandy islets, intertidal waters and lagoonal waters serve as critically important refugia for both of these species for their pupping and nesting activities. In fact, FFS represents the primary pupping ground for the Hawaiian Monk Seal, and is where the vast majority (90%) of Hawaiian Green Sea Turtles nest throughout the entire Hawaiian Archipelago. Additional concerns relate to inexperienced monk seal pups following, and interacting with, the wide variety of deployed gear, anchored gear, buoyed gear and other in-water activities, proposed by the Applicant to occur within lagoonal and intertidal waters at FFS.

3. The Applicant's primary rationale for conducting such a wide range of extractive activities within a completely closed no-take MPA is weakened by the large number of repetitive samples for each species to be taken, including many which have already been sampled previously at FFS by previous research expeditions (including at least two this

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[1] The Applicant proposes 1000m^2 x twice a day for 15 days x100cm wide (i.e. 1 m x 1000 km^2 x 15 days x 2 times/day = over 30 kilometers of damage within the lagoonal waters at FFS!). Dredging is extremely destructive to bottom habitat and is specifically prohibited from most large no-take MPAs in the USA - we have no knowledge how long this damage would persist at FFS.

year). Furthermore, proposals to split the samples and distribute them amongst various mainland Museums (which appear to be sending collection teams to participate in this activity) raise concerns regarding this application representing an alternative form of "bioprospecting", whereby widescale, non-selective extraction of a wide variety of unique species is conducted, in this case, to enhance mainland museum collections.

4. Some DAR staff strongly question how the focus on a wide variety of microendosymbionts, cryptic organisms, microbes, and infaunal organisms can reasonably be expected to improve existing resource management of a completely closed no-take area at FFS in proportion to the impact damage caused by the extraction activities themselves required to acquire the samples over a wide area within the confines of FFS. Given that the area is completely no-take (except for expeditions such as this), and is no-entry out to the State's 3 mile limit (and beyond, out to 50 miles through the National Monument status), how can we manage these resources any more protectively other than to minimize the primary human impact in this area posed by extractive research activities such as the one proposed? How will the natural resources or the people of Hawai'i be compensated for these extraction impacts?

In accordance with these concerns, if a State NWHI permit is to be issued, DAR proposes that the following be allowed for the activities as specified in the Application (as amended) and as outlined below with the following special instructions and conditions:

1. Allow the entry of the NOAA Ship *Oscar Sette* into State waters to support Applicant's modified collection tables and activities at French Frigate Shoals only.

2. That the following activities be regulated as follows.

Sampling Method	Allowed Habitats	Allowed Target Organisms	Allowed Sampling Effort	Allowed Samples[2]	Special Sampling Method-Specific Conditions
Hand Collecting	All proposed habitats except Acropora areas.	Sessile/ Mobile Epifauna; sponge communities. Other special conditions as defined below.	No more than 20 rubble pieces will be disturbed by this method per dive.	2 samples per species max. per trip. Other special conditions as defined below.	No live coral collection. No take of live rock that is attached to the overall substrate. All live rock sampled will not be removed from the water and will be placed back in its original position after organisms have been sampled. No take of any individual or colonial organism >5cm which is already known from FFS or the NWHI.
Live Rock ("Rubble") Extraction	Reef crest, inter-tidal, lagoonal sand, and Halimeda field habitats **ONLY**.	Motile Cryptic Invertebrates. Other special conditions as defined below.	No more than 4 rubble pieces will be disturbed by this method per dive.	2 samples per species max. for whole trip. Other special conditions as defined below.	No live coral collection. No take/use of any live rock that is attached to the overall substrate. No take/use of loose pieces larger than 40 cm longest diameter. All collection substrates (for each individual collection) will be photographed both pre- and post collection, and the collection point GPS'd.
Rubble Brushing	Fore reef, Reef Crest, Back reef, Lagoon Patch Reef, Intertidal Shores, La Perouse, Ark Shell Reefs.	Mobile Epifauna. Other special conditions as defined below.	Maximum of 5 m^2 area brushed per site.	2 samples per species max. for whole trip. Other special conditions as defined below.	No live coral collection. No take/use of any live rock that is attached to the overall substrate. No take/use of loose pieces larger than 40 cm longest diameter. All collection substrates (for each individual collection) will be photographed both pre- and post collection, and the collection point GPS'd. After brushing, the live rock is replaced on the bottom in the same position that it was found.
Sand Sampling	Lagoonal sands **ONLY** Sample sites must be large sand (> 50m^2) areas.	Mobile Epifauna, Infauna Other special conditions as defined below.	Maximum of 15 gallons of sand per site disturbed. Maximum of 2 sites total.	2 samples per species max. for whole trip. Other special conditions as defined below.	No live coral collection. No take/use of any live rock that is attached to the overall substrate. No disturbance of non-sand habitats. All collection substrates (for each individual collection) will be photographed both pre- and post collection, and the collection point GPS'd.

[2] For any given species, organisms over 2 cm in longest diameter. For individual organisms for any given species under 2 cm, limit is 3cm^3 total combined amongst all samples for that method.

Sampling Method	Allowed Habitats	Allowed Target Organisms	Allowed Sampling Effort	Allowed Samples[3]	Special Sampling Method-Specific Conditions
Plankton Nets	Upper water column **ONLY** Fore reef, lagoonal areas **ONLY**	Plankton **ONLY**	Maximum of 10 sites.	2 samples per species max. for whole trip. Other special conditions as defined below.	Subsurface tows with a 1 m diameter. Plankton tow activities will cease immediately, and retrieve all in-water gear, if sea turtles or monk seals are visible in the surface waters at the location.
Artificial Reef Matrix Structures (ARMS)	Forereef, Backreef, Lagoonal Patch Reef **ONLY**	None - Placement of ARMS only.	None - Placement of ARMS only.	None - Placement of ARMS only.	Applicant may place 12 total ARMS (2 x 3 forereef sites, 2 backreef sites, 2 x 2 lagoonal patch reef sites. Stainless steel stakes only will be used to anchor ARMS. No disturbance of live rock or live coral. No ARMS will be installed within 2 m of any large coral colony. All ARMS locations (for each individual ARMS) will be photographed both pre- and post installation, and the installation point GPS'd.
Light Traps	Upper water column **ONLY**	Planktonic larvae and adults **ONLY.**	Maximum of one light trap per site per night.	2 samples per species max. for whole trip. Other special conditions as defined below.	No anchoring of light traps to the substrate allowed. Light trap activities will be directly supervised at all times while in the water to prohibit seabird, monk seal and sea turtle interactions. Light trap activities will cease immediately, and retrieve all in-water gear, if sea turtles or monk seals are visible in the surface waters at the location.
Yabbie Pump	Lagoonal sands and Intertidal shores, La Perouse **ONLY**	Infauna and Burrowing Epifauana **ONLY.**		2 samples per species max. for whole trip. Other special conditions as defined below.	No disturbance of live rock or live coral. All collection substrates will be photographed both pre- and post collection, and the collection point GPS'd.

[3] For any given species, organisms over 2 cm in longest diameter. For individual organisms for any given species under 2 cm, limit is $3cm^3$ total combined amongst all samples for that method.

Sampling Method	Allowed Habitats	Allowed Target Organisms	Allowed Sampling Effort	Allowed Samples[4]	Special Sampling Method-Specific Conditions
Baited Traps	Lagoonal sands **ONLY** Use in State waters is limited to depths where the individual traps can be placed on the bottom directly by divers.	Mobile Epifauna **ONLY**	Maximum of 5 single traps per night. No untended surface deploy-ment allowed.	2 samples per species max. for whole trip. Other special conditions as defined below.	No disturbance of live rock or live coral. All traps placed will be placed by divers to ensure no interaction with coral or live rock. All collection substrates where traps are to be placed will be photographed both pre- and post collection, and the specific trap location GPS'd. No lobsters, large mollusks, or large crabs will be collected; any found within the trap will be released prior to the trap being lifted off the substrate. All bait used will meet NOAA frozen fish food standards for marine mammals. Traps will not be set in locations where sea turtles or monk seals are visible in the surface waters.
Ekman Grab (or Van Veen Grab)	Lagoonal Sand, Deep sand (>30m depth) **ONLY**. Sample sites must be large sand (> $50m^2$) areas.	Infaunal Organisms **ONLY**	3 grab attempts per site maximum. Maximum of 3 sites/day.	2 liters of sand per site. 2 samples per species max. for whole trip. Other special conditions as defined below.	No disturbance of live rock or live coral. All collection sites will be GPS'd and all samples labeled and photodocumented. Ekman Grab activities will cease immediately if live rock or coral is observed in any of the grab samples. That location will be abandoned, but will count towards the maximum locations sampled per day. Ekman Grab activities will cease immediately, and retrieve all in-water gear, if sea turtles or monk seals are visible in the surface waters at the location.
Microbial Collections	Water column, sediment **ONLY**.	Microbes **ONLY**.			No disturbance of live rock, live coral, or any macro-organism through targeted collection efforts. Non-invasive techniques will be used to sample the water column and sediment. Microbes will be killed and not preserved in any way for re-activation. Samples will be documented as dead and not frozen or otherwise inactivated. No lipid extractions will be allowed.

[4] For any given species, organisms over 2 cm in longest diameter. For individual organisms for any given species under 2 cm, limit is $3cm^3$ total combined amongst all samples for that method.

Sampling Method	Allowed Habitats	Allowed Target Organisms	Allowed Sampling Effort	Allowed Samples[5]	Special Sampling Method-Specific Conditions
Algal Collections	Backreef, Reef Crest, Halimeda Fields, Arc Shell Reef **ONLY**	Macro and Turf Algae **ONLY.** **NO Crustose Coralline Algae or Endolithic Algae Allowed.**	One gallon sized bag (wet weight) per site.	2 samples per species max. for whole trip. Other special conditions as defined below.	No disturbance of live rock, live coral, or any clonal sponge, bryozoan, arc shell assemblage, sea grass meadow, soft coral or zoanthid mat. All collection sites will be GPS'd and all samples labeled and photodocumented.
Suction	Forereef, Backreef, Reef Crest, Lagoon Patch Reef **ONLY.**	Cryptic epifauna **ONLY.**	Can only be used on exposed hard bottom habitats. Maximum of 3 m^2 per site; maximum of 3 sites/day.	2 samples per species max. for whole trip. Other special conditions as defined below	No disturbance of live rock, live coral, or any clonal sponge, bryozoan, sea grass meadow, soft coral or zoanthid mat. All collection sites will be GPS'd and all samples labeled and photodocumented.
Crypto-fauna Analysis	**Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	Collection of prime live rock habitat which serves as fish and invertebrate shelter - Not allowed on this expedition.
Scoop	**Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	**None – Not Allowed in State Waters.**	Large scale (30 kilometers) of damage to bottom habitats within the no-take FFS lagoonal waters is not justified at this time. At no time will ANY lines or gear associated with "Scoop" or dredging activities be deployed in State waters.

[5] For any given species, organisms over 2 cm in longest diameter. For individual organisms for any given species under 2 cm, limit is $3cm^3$ total combined amongst all samples for that method.

3. No other collections, in-water activities, or take of any sort other than those listed above will be undertaken or employed. No incidental take of fish or other animals not targeted above. No live coral colonies will be impacted by this activity. Gear and methods as listed above will only be used (and carried aboard tender vessels) in those habitats allowed for each method.

4. Collecting Practices:

    a. Collecting activities under authority of this permit must be authorized and supervised directly, on site, by the undersigned Permittee or his appointed representative who shall take special caution to avoid any over collection or undue damages. No personnel shall be allowed to conduct collecting activities absent such authorization and supervision.

    b. The permittee must notify the DAR immediately in the case of major damage caused to coral or other marine resources as a result of collection or any other research activities conducted under this permit.

    c. No live rock assemblages larger than 1 m longest diameter will be targeted. No fragmentation of any live coral or live rock will take place underwater.

    d. While this permit will provide for a maximum of 1 gallon in volume (wet weight) of algae per allowed sampling site, it is expected that such collections will be limited to algae which is thought, upon macroscopic examination, to be either a new species or new record at FFS. Voucher specimens will be deposited with the Bishop Museum. No crustose coralline algae or endolithic algae will be targeted for collection.

5. This permit will authorize collecting, killing, and in-State transport of dead material only, subject to the other conditions of this permit. No out-of-State transport of any samples or biological products is allowed without prior written approval from DAR and legal signatures from any receiving parties agreeing to abide by all applicable conditions of this permit.

6. Organisms taken from State NWHI waters under authority of this permit may be used only for scientific study on O'ahu, except as authorized by prior written approval of the Division to conduct the following activities:

    a. Selling of any organisms or products of organisms collected under this permit.

    b. Exchanging or donating any organisms collected under this permit to any other person, party or organization.

7. Allow the collection of new species and records from the NWHI at FFS which have not been previously recorded or collected from FFS. Note that the wide variety of activities and gear to be employed on this expedition and the independent collection efforts of various lead scientists will tend to lead to repetitive collection of the same species resulting in significant cumulative impacts and bycatch. To address some of this concern, CUMULATIVE collection of any given species larger than 5 cm across all methods under this permit will be 6 specimens MAXIMUM;

with no species larger than 5 cm being collected which is already known from the NWHI (as referenced in the attached extensive species list).

8. No take/use/disturbance of any live coral, pearl oyster, sea turtle, or monk seal.

9. Allow for collection of limited number of organisms as defined above with the following protocols:

   a. No extractive or invasive sampling will be done in, on, or around, any intact coral colony measuring larger than 1 m x 1 m x 1 m. Specific efforts will be made to avoid damage to any large colonies of coral.
   b. No coral species will be collected or impacted by any activities conducted under this permit.
   c. The permittee must notify DAR O'ahu within one day of any instance of major damage caused to coral or other marine resources as a result of collection or other research activities conducted under this permit.

10. All anchoring activities within the lagoonal waters of FFS will involve directed placement of the anchor to avoid damage of coral, live rock, seagrass meadow and other habitats of concern. Anchoring will be done on sand or rocky substrate only.

11. Pursuant to Section 188-23, Hawai'i Revised Statutes, any use of electrical shocking devices, explosives or chemical substances is expressly prohibited, except to the extent that the following chemicals are allowed with limitations as follows:

    a. A limited amount (2 liters each) of formalin, magnesium chloride, chloretone, menthol crystals, and ethanol will be allowed aboard the NOAA ship *Oscar Sette* for the on-board preservation of specimens.

    b. A limited amount (10 liters) of concentrated chlorine bleach solution will be allowed aboard the the NOAA ship *Oscar Sette* for the decontamination of in-water gear, lab surfaces and tender vessels. Diluted chlorine bleach (10%) disposal will occur as listed below under Disease Protocols.

    c. No chemicals substances as referred to above will be carried aboard any of the tender vessels operating in, or by any individuals entering, State waters of the NWHI.

12. Disease Protocols:

    a. All sampling and dive gear will be disinfected in an enclosed container for 10 minutes or more between sites with a fresh 10% bleach solution in order to kill any microorganisms and eliminate the possibility of disease transmission by researchers.

    b. Wet lab surfaces will be wiped down after each activity with a fresh 10% bleach solution in order to kill any microorganisms and eliminate the possibility of disease transmission by researchers.

    c. Tender vessels that have been inside FFS lagoonal waters (where diseased organisms are known to occur) will be disinfected by wiping down their internal and external surfaces with a fresh 10% bleach solution in order to kill any microorganisms and eliminate the possibility of disease transmission by researchers. This will occur when the vessel is outside State waters and prior to the support vessel leaving the immediate vicinity of French Frigate Shoals.

    d. Disposal of any water containing 10% bleach solution from above activities will occur outside State waters under applicable Federal and International laws.

13. A daily log will be maintained by the Chief Scientist and/or Scott Godwin aboard the vessel, whereby all organisms collected by various assistants will be documented on a daily basis relative to what was collected, the amount, the size of the specimens, the location (including specific GPS points), and the status of the specimen(s). The log entry will be signed by the person who collected the organisms and countersigned by either the Chief Scientist or Mr. Godwin after validation of the collection; this log will constitute a legal document for enforcement purposes and be submitted to DAR O'ahu at the end of the expedition. All specimens collected for all activities will be logged daily as described above.

14. A log or report of all waste disposal occurring aboard the vessel during the cruise shall be submitted to DAR O'ahu with the mandatory cruise report; log shall be maintained for all discharge occurring aboard the vessel and include time, date, volume, description of what was released and who released it and shall be signed by the Ship's Captain.

    No Black water, food scraps, solids, chemicals, or waste liquid will be released into State waters.

15. The Applicant will provide for all permittees (including <u>all</u> assistants) to go through a pre-cruise mandatory briefing by DAR staff regarding the permit conditions and legal repercussions of non-compliance.

RECOMMENDATION:

"That the Board authorize to issue, with stated conditions, a NWHI Research, Monitoring and Education Permit to Dr. Russell Brainard of the National Oceanic and Atmospheric Administration, for access and certain activities within the designated State waters of the NWHI State Marine Refuge."

Respectfully submitted,

DAN POLHEMUS
Administrator

APPROVED FOR SUBMITTAL

PETER T. YOUNG
Chairperson

APPENDIX 1

State of Hawai'i
DLNR
Northwestern Hawaiian Islands State Marine Refuge
Permit Application Form

For Office Use Only
Permit No:
Expiration date:
Date Appl. Received: 9/11/06 JG
Appl. Fee received: N/A
NWHI Permit Review Committee date: Various
Board Hearing date: 9/22/2006
Post to web date:

06-472
DG

Type of Permit

☒ I am applying for a **Research, Monitoring & Education** permit. (Complete and mail Application)
- ☒ This application is for a NEW project in the State Marine Refuge.
- ☐ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

☐ I am applying for a permit for a **Native Hawaiian** permit. (Complete and mail Application)
- ☐ This application is for a NEW project in the State Marine Refuge.
- ☐ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

☐ I am applying for a **Special Activity** permit. (Complete and mail Application)
- ☐ This application is for a NEW project in the State Marine Refuge.
- ☐ This application is for an ANNUAL RENEWAL of a previously permitted project in the State Marine Refuge.

Briefly describe **Special permit** activity:

When will the NWHI activity take place?

☐ **Summer** (May-July of _____ (year)
Note: Permit request must be received before February 1st
Specific dates of expedition _____

☒ **Fall** (August-November) of _2006___ (year)
Note: Permit request must be received before May 1st
Specific dates of expedition _October (25 days)

☐ **Other**

NOTE: INCOMPLETE APPLICATIONS WILL NOT BE ACCEPTED

Please Send Permit Applications to:

NWHI State Marine Refuge Permit Coordinator
State of Hawai'i
Department of Land and Natural Resources
Division of Aquatic Resources
1151 Punchbowl Street, Room 330
Honolulu, Hawai'i 96813

NWHI State Marine Refuge Permit Application
See Appendix 2 for Application Instructions

Section A – Applicant Information	
1. Project Leader (attach Project Leader's CV or resume) ☒ CV attached Brainard, Russell E. Name: Last, First, Middle Initial	Chief, Coral Reef Ecosystem Division (CRED) Title
2. Mailing Address (Street/PO Box, City, State, Zip) NOAA Pacific Islands Fisheries Science Center 1125B Ala Moana Blvd Honolulu, HI 96814	Telephone (808) 983-3737 Fax (808) 983-3730 Email Address rusty.brainard@noaa.gov
3. Affiliation (Institution/Agency/Organization) NOAA National Marine Fisheries Service Pacific Island Fisheries Science Center (PIFSC)	For graduate students, Major Professor 's Name & Telephone
4. Sub-Permittee/Assistant Names, Affiliations, and Contact Information ☒ CV or resume attached Project leads are: Dr. Gustav Paulay, Florida Natural History Museum, Associate Curator of Marine Malacology, Professor of Zoology Dr. Nancy Knowlton, Scripps Institution of Oceanography, Professor of Marine Biology, Director of the Center of Marine Biodiversity and Conservation Dr. Joel Martin, Los Angeles County Natural History Museum, Curator of Invertebrates, Professor of Biology Dr. Peter Vroom, Pacific Islands Fisheries Science Center, Marine Algal Biologist	
5. Project Title Census of Coral Reef Ecosystems (CReefs): Understudied Species and the Biodiversity of French Frigate Shoals (alt: Maro Reef), Northwestern Hawaiian Islands Marine National Monument	
6. Applicant Signature	7. Date (mm/dd/yyyy)

Section B: Project Information
8. **(a) Project Location** ☒ NWHI State Marine Refuge (0-3 miles) waters surrounding: ☐ Nihoa Island ☐ Necker Island (Mokumanamana) ☒ French Frigate Shoals ☐ Laysan ☐ Maro ☐ Gardner Pinnacles ☐ Lisianski Island, Neva Shoal ☐ Pearl and Hermes Atoll ☐ Kure Atoll, State Wildlife Refuge ☐ Other NWHI location

Describe project location (include names, GPS coordinates, habitats, depths and attach maps, etc. as appropriate).

All areas surrounding French Frigate Shoals. We will survey up to three stations at each habitat type listed below, with three replicates per station.

Forereef (5, 10, 25m)
Reef crest (0-1m)
Back reef (1m)
Intertidal shores (0-1m)
Lagoon sand (5-10m)
Lagoon patch reef (5-10m)
Deep bank tops (30-100m)
Deep reef slopes (50-200m)
La Perrouse
Arc shell reefs
Acropora areas
Halimeda fields

Also specific stations will be determined by weather and sea conditions.

(b) check all actions to be authorized:

☒ Enter the NWHI Marine Refuge waters

☒ Take (harvest) ☒ Possess X Transport (x Inter-island x Out-of-state)

☒ Catch ☒ Kill ☒ Disturb ☒ Observe

☒ Anchor ☒ Land (go ashore) ☐ Archaeological research

X Interactions with Sea Turtles or Monk Seals X Interactions with Seabirds

X Interactions with Live Coral, Ark Shells or Pearl Oysters

X Interactions with Jacks, Grouper or Sharks

☐ Conduct Native Hawaiian religious and/or cultural activities

☐ Other activities _____

NOTE: Should the scientists on this mission encounter sea turtles, monk seals, seabirds, jacks or sharks, they will take every precaution not to approach, disturb and/or interact with them. It should be noted that such encounters/interactions will not be intentionally sought out.

(c) Collection of specimens – collecting activities (would apply to any activity):

To assess the biological diversity and improve our understanding of the coral reef ecosystem of French Frigate Shoals and the Northwestern Hawaiian Islands, we will need to sample on average 10 specimens per species found. Given that the scope of this cruise is to identify and collect new species, we cannot predict the number and type of species that may be collected. Attached is a list of species published by the Bishop Museum known to inhabit French Frigate Shoals. Algal species lists can be found in the following books, "The Marine Red Algae of the Hawaiian Islands" by Isabella A. Abbott (1999) and "The Marine Green and Brown Algae of the Hawaiian Islands" by Isabella Abbott and John Huisman (2004). These lists will help determine which species to avoid if possible and as species from the proposed cruise are identified, we will be able to enhance the datasets listed to create more complete species lists.

Of each species taken (ranging microbial to 60cm in size), specimens of varying sizes will be collected.

Although it is not our intent to collect species that are already well known, given the innate difficulty in identifying rare or small species in the field some of these may be collected for future reference, to serve as type specimens for species new to science, or for needed biodiversity information. These species will also prove helpful in DNA barcoding and with species where more samples may be needed within the scientific community. If unneeded specimens are collected and it is determined that they can be accurately returned to the location of collection, every effort will be made to return them alive. For some collection methods such as the "Ekman grab", this will not be possible, while for others such as "hand collection" and "rubble brushing" we will return specimens to their respective locations when possible. No organisms will be kept alive after collection, except those which will be returned to their place of capture. Special care will be taken not to transport species between sites within the Atoll. This will be done by rinsing all dive gear and collection materials daily in fresh water, by thoroughly flushing the small boats daily, and by not intentionally returning organisms to the reef unless it is to their original location.

Amongst the specialists on this cruise, there will be a non-diving component dedicated to sorting and identifying collected specimens on board the ship and/or in a lab at Tern Island. The diving and non diving experts alike will work to identify and sort a large number of the specimens (the lesser known species will be sorted into broad taxonomic groups) during the cruise itself. Samples collected will be sorted to species in the field and assigned names--each will be given a unique identifying number. An estimated one half will be directly identifiable to genus and one third will be identifiable to species in the field. As the organisms are processed, they will be entered into a CRED/CReefs cruise database in conjunction with the recently established, successful Moorea Biocode Database. (More regarding database population in next section)

Several members of the scientific staff will be CRED personnel who are highly experienced with research within the Northwestern Hawaiian Islands. The scientists we are bringing together for this cruise are donating their efforts out of concern for the conservation of marine biodiversity--this provides an opportunity for the State of Hawaii to increase capacity to describe biodiversity in Hawaii by working with Bishop Museum, HIMB and other Centers of Excellence in invertebrate, algal, and microbial taxonomy. The experts taking part in this cruise have the respect for and knowledge of the area that is needed to conduct collections with minimal impact. If encountered, monk seals, turltles, dolphins, and other megafauna will be left undisturbed to the maximum extent possible--all rules and regulations being followed. NOAA conducted cruises hold to very strict standards and thus a pre-cruise meeting will be held, addressing rules and regulations as well as general respect for the areas in which we will be working. We plan to further discuss environmental matters with concerned groups prior to the meeting to generate a more thorough briefing. U.S. Fish and Wildlife Service representative Jim Maragos will also be participating in this cruise and will provide further knowledge and expertise as well as guidance and enforcement. All samples collected will be documented and reported to customs and the co-trustees of the NWHI Marine National Monument.

Organisms or objects (List of species, if applicable, add additional sheets if necessary):

Common Name	Scientific Name	No. & size of specimens	Collection Location(s):

See attached list from the Bishop Museum of invertebrate species known at French Frigate Shoals. Algal species are listed in two books, "The Marine Red Algae of the Hawaiian Islands" by Isabella A. Abbott (1999) and "The Marine Green and Brown Algae of the Hawaiian Islands" by Isabella Abbott and John Huisman (2004).

(d) What will be done with the specimens after the project has ended?

Post-cruise, funding/resources depending, species can be matched up and catalogued over the course of approximately one year's working hours. Following this, specialists would need to investigate unknown species, which would take place over a period of time-- resource/funding dependent. The experts taking part in this cruise are dedicated to this effort and thus all concerned would like to see timely specimen

identification. A number of the experts will be able to conduct further work on the samples post-cruise, resources permitting. The researchers are donating their time, expertise, and resources to this project--there is currently no funding to support their efforts and consideration must be made for other tasks that they may be committed to. Relevant funding opportunities that present will be pursued and discussions with management personnel and experts are already underway to support the timely identification of the specimens. Regardless of financial constraints, the identification of very rare species and the designation and naming of a new species are innately time-consuming processes, sometimes taking years to accomplish. All efforts will be made to responsibly and promptly process the samples given the aforementioned constraints.

The specimens from this effort will be allocated to taxonomic experts with regard to their areas of expertise for further research and identification in their respective labs. Invertebrate samples will be curated at the Bishop Museum (BPBM), the Natural History Museum of Los Angeles County (LACM), and the Florida Museum of Natural History (FLMNH). Marine algae specimens will be processed in the University of Hawaii Botany Lab and then deposited in either the NOAA-CRED herbarium or the Herbarium Pacficum at the Bishop Museum in Honolulu, Hawaii. The University of California Merced and the Marine Biological Laboratory at Woods Hole, MA will be the institutions responsible for processing microbial samples. Though all samples will be the property of the state of Hawaii, it is critical to combine efforts between these institutions as they have the experts and resources through which many of these samples can be identified (also because such resources are currently limited in the state of Hawaii). Samples housed outside of Hawaii will be considered long term loan and will be available to interested parties upon request to the housing museum or agency.

Tracking of the samples will initially be maintained through the Moorea database, which will be updated as the samples are transferred for further work. Sample information will be tied in with how samples are stored, where, and contact information. The data will be integrated directly from the cruise into existing Pacific Basin and global coral reef data already residing in the Pacific regional database—the National Biological Information Infrastructure's (NBII) Pacific Basin Information Node (PBIN--http://pbin.nbii.org) and the Ocean Biogeographic Information System (OBIS-- http://www.iobis.org), an on-line, open-access, globally-distributed network of systematic, ecological, and environmental datasets, making it available to managers and the public. In 2007 it will be joined by data from NOAA's Reef Assessment and Monitoring Program and the National Coral Reef Ecosystem Monitoring Grant Program—an effort recently approved for funding by the Pacific Region Integrated Data Enterprise program. In this multi-agency partnership, NCCOS, CRED, and CReefs will require that biological data from their respective research missions be put into the regional PBIN database (data relative to the Pacific Basin) and the international OBIS. Data from Bishop Museum already populates these databases and a primary goal for CReefs is to assist integration of other major coral reef datasets into these databases.

(e) Will the organisms be kept alive after collection? ☐ yes ☒ no

- Specific site/location _____
- Is it an open or closed system? ☐ open ☐ closed
- Is there an outfall? ☐ yes ☐ no
- Will these organisms be housed with other organisms? If so, what are the other organisms?

(Please attach additional documentation as needed to complete the questions listed below)

9. Purpose/Need/Scope:

- State purpose of proposed activities:

The overall objective of the proposed CoML Census of Coral Reef Ecosystems (CReefs) project, led by NOAA's Pacific Islands Fisheries Science Center (PIFSC) Coral Reef Ecosystem Division in support of NOAA's Coral Reef Conservation Program, is to investigate and document the biological diversity of understudied reef-associated non-coral invertebrates, turf and coralline algae, and microbial communities at French Frigate Shoals in the recently designated Northwestern Hawaiian Islands (NWHI) Marine National Monument (MNM). As a potential alternate location for the CReefs biodiversity assessment, we are proposing Maro Reef, also in the Northwestern Hawaiian Islands. This project is unique in documenting diversity in ecologically critical, but non-charismatic, commercially unimportant organismal groups (across a range of habitats) that have historically been understudied because of lack of taxonomic expertise or logistical difficulties in sampling. In addition to using traditional morphological taxonomic identifications, DNA from these poorly understood species will be used in a bar-coding study to help future researchers identify taxonomically challenging taxa. Data collected will be input into regional and global databases and outreach and education personnel will package scientific findings and expedition notes into multiple formats that can be used for a variety of educational and outreach purposes. Diversity will be documented for managers, public stakeholders, and the scientific community with a rich variety of specimens, photographs, and genetic samples. With the proposed research, we plan to assist managers by providing a more complete picture and baseline information regarding this pristine ecosystem and the species within it that they are charged with protecting. We will do this by combining our research efforts with existing research, providing a more complete species inventory, thereby filling critical gaps in information, and by providing research which will aid in a greater understanding of biodiversity on a local, national, and global scale.

As part of the international Census of Marine Life, supported by government and non-governmental agencies concerned with science, environment, and ecosystem approaches to management in a growing list of over 73 nations, this will be the first CoML project to provide a means for improving our understanding of the biodiversity of coral reef ecosystems at French Frigate Shoals, the Northwestern Hawaiian Islands, as well as on a global level and to aid in the protection of all coral reef species by identifying especially rare and vulnerable species. Three major goals of the Census of Marine life program are (1) to establish effective research programs that provide species, genetic, and community-level information to support ecosystem-based management, (2) to improve capacity for ecosystem-based management and predicting ecosystem change through retrospective analysis, the development of improved tools, and the establishment of a data management system of marine biodiversity information, and (3) to establish within the U.S., effective long-term mechanisms for the dissemination of information about marine biodiversity and public engagement in ocean issues. We will contribute to these goals by bringing together experts in the fields of invertebrate, algal, and microbial taxonomy to thoroughly survey various marine habitats at French Frigate Shoals, to establish community based species lists and to document previously unknown species. The research we are proposing here is unprecedented in the level of taxonomic expertise that will be brought together to conduct ship-based Census of Marine Life (CoML) censuses of the most poorly known taxonomic groups at French Frigate Shoals in the fall of 2006 (with a shorter, possible piggy-back mooring recovery cruise in the fall of 2007).

Describe how your proposed activities will help provide information or resources to fulfill the State Marine Refuge purpose and to reach the Refuge goals and objectives.

- Give reasons why this activity must take place in the NWHI and cannot take place in the Main Hawaiian Islands, or elsewhere.

The CoML is a global research initiative that assesses and explains the diversity, distribution, abundance, and functional relationships of life in the oceans. Identifying important species in marine ecosystems over spatial and temporal scales will greatly improve our understanding of the biology of the oceans and our ability to conserve ocean resources for future generations. The US National Committee (USNC) of

CoML was established in 2002 to expand US participation in this global initiative by taking into account national priorities such as assessing biodiversity in US waters and examining diversity and subsequent health of US reefs in the context of global patterns. In recognition that CoML did not have a project focusing on coral reef ecosystems, the USNC and CoML secretariat convened a workshop in Hawaii in August 2004 with 43 coral reef experts from 32 academic institutions, government agencies, and NGOs. Participants identified priority research activities to complement existing US and global coral reef initiatives and serve as a basis for future CoML activities related to coral reef ecosystems. From this multi-agency cooperation to address and prioritize coral reef concerns/needs, the CReefs project came to fruition, its mission to increase tropical taxonomic expertise, conduct a taxonomically diversified global census of coral reef ecosystems, and improve access to and unite coral reef ecosystem information scattered throughout the globe. Though this effort needs to take place throughout the world's oceans, it is critical that baseline sites (Census of Coral Reefs centers for excellence) are carefully considered. The USNC and workshop participants took this into consideration while prioritizing locations for survey, at which point the Northwestern Hawaiian Islands became a priority for a census of coral reefs.

The NWHI are highly favored as a sampling site because of the continual protection they have received since 1909 as part of the Hawaiian Islands National Wildlife Refuge (HINWR) under the jurisdiction of the US Fish and Wildlife Service (USFWS). In 2000 and 2001, protections for the NWHI were further increased with the designation of the NWHI Coral Reef Ecosystem Reserve (CRER) by Presidential Executive Orders. In 2005, the State of Hawaii inacted the Northwestern Hawaiian Islands Marine Refuge for the long term conservation and protection of the unique coral reef resources and the related marine resources and species within State waters and to ensure their conservation and natural character for present and future generations. On June 15, 2006, a Presidential proclamation was issued establishing the NWHI Marine National Monument, representing the world's largest marine protected area (MPA) in the United States. In his speech to announce the declaration President Bush said "the new national monument creates a new opportunity for ocean education and research for decades to come. Successful ocean stewardship depends on informed policy makers and an informed public..." Jean-Michel Cousteau put it this way, he said, "How can we protect what we don't understand? Ninety-five percent of our planet's oceans have yet to be explored... The waters of this new national monument will be a living laboratory that offers new opportunities to discover new life, that helps us better manage our ocean ecosystems, and allows us to pursue advances in science." Because of this protection, the NWHI are globally recognized to contain among the healthiest apex predator dominated coral reef ecosystems in the world. In addition the species present in the NWHI contain a high degree of endemism, making the biological composition of the region unique and important for the protection of especially rare and vulnerable species. To effectively manage and conserve biodiversity in the NWHI and to evaluate future changes in biodiversity or introductions of marine invasive species, it is essential to have detailed inventories of the existing species composition.

French Frigate Shoals (FFS), at the center of the Hawaiian Islands, is the ideal locale for a census because of its pristine nature and because of its nexus to three distinct biogeographical nodes and perhaps has served as an important pathway for the spread of organisms through proximity to its nearest neighbor, Johnston Atoll to the south. The fauna of Johnston Atoll appears to have biogeographic ties with the Hawaiian Islands (Springer 1982; Robertson et al. 2004; Mundy 2005) and recent studies on larval transport suggest that Johnston Atoll is a stepping stone to species colonization in the Hawaiian Archipelago—in particular, FFS (Kobayashi 2006). Several reports (Maragos et. al 2004) indicate that the atoll has the highest shallow coral reef biodiversity of any islands and reefs in Hawaii, and perhaps has served as an important pathway for the spread of species from three directions. Also, because of the presence of both atoll and basalt features, FFS supports one of the widest ranges of reef habitats in the Hawaiian Archipelago (Grigg and Dollar 1980, Maragos and Gulko 2002). Because of its key location, numorous habitat types, pristine nature, and a wealth of existing supplemental data that could be tied into this study, FFS could serve as a baseline comparison for possible future studies in the Main Hawaiian

Islands, NWHI, and Johnston Atoll, as well as research conducted on a global scale. Furthermore, and most importantly, because of its location and significance, FFS has been widely surveyed for other goals and many research efforts are focused there. As a result, a serious concern is that of impact by the groups visiting FFS. Before further or greater impact take place, a baseline study is critical!

As a potential alternate location for the CReefs biodiversity assessment, we would propose Maro Reef because it has many of the same attributes as French Frigate Shoals. It has most, but not all, of the diverse habitat types found at French Frigate Shoals. Interestingly, Maro Reef has only the retriculated reefs of an atoll lagoon, but without the any surrounding barrier reef. Apparently, the barrier reef began submerged millions of years ago, but the interior retriculated reefs have survived and thrived. Due to this unique formation, Maro Reef is somewhat unique in the Hawaiian Archipelago and may hold many surprises in terms of biodiversity. Nevertheless, Maro Reef is also situated near the central, high biodiverity, corridor of the Hawaiian Archipelago. Having virtually no exposed land, Maro Reef has never been subjected to significant human occupation, dredging, or other activities (with the exception of commercial lobster fishing around the surrounding bank). The land of suitable haulout habitat also significantly limits the presence of endangered Hawaiian monk seals. Unlike French Frigate Shoals, much of the shallow coral reef habitats surrounding Maro Reef are not within the boundaries of the NWHI Marine Refuge of the State of Hawaii. As such, it's possible, but not desirable, that surveys could be conducting entirely outside of State waters. One of the downsides of conducting the CReefs survey at Maro Reef is the open exposure and lack of adequate protection from weather to conduct operations. We also have a significantly less well developed understanding of the fauna and habitats of Maro Reef compared with French Frigate Shoals.

By cataloging the biodiversity of these coral reef ecosystems this project will provide managers with one of the most complete records of inhabitant species that exists at any coral reef MPA. This information will have utility not only for local managers but also for managers of coral reef MPAs throughout the Pacific and globally.

- Describe context of this activity, include history of the science for these questions and background.

Since 2000, NOAA PIFSC CRED has been conducting research cruises to the NWHI for its Pacific Reef Assessment and Monitoring Program (RAMP). CRED conducts long-term monitoring of biodiversity and abundance of coral reef organisms at 55 islands, atolls, reefs, and banks in five archipelagic systems spanning the Pacific Ocean Basin. This ecosystem-based approach examines fish, corals, macroinvertebrates, and algae, thereby allowing for comparison of species richness across broad ocean regions at a level of scrutiny unavailable prior to the creation of Pacific RAMP. For instance, on islands where initial monitoring assessments are complete, knowledge of algal diversity has increased from 400% to 1000%, with several species new to science described. Taxonomic comparisons of algae across the Pacific now provide insight into connectivity among remote oceanic islands. Similarly, many new fish species records have been noted for a number of islands, some where no previous records have existed, including discovery of new species. Coral surveys have greatly increased knowledge of species ranges in all island groups visited. In French Frigate Shoals, in conjunction with 2000 and 2002 monitoring efforts, initial collections of marine invertebrates and algae were accomplished, but these were focused strictly on common organisms within coral reef habitats and did not span the breadth of habitats and other species that exist within an atoll such as French Frigate Shoals.

NOAA's National Centers for Coastal Ocean Science for Coastal Monitoring and Assessment (CCMA) assesses and forecasts coastal and marine ecosystem conditions in the Pacific through research and monitoring. NCCOS data and models help coastal managers predict the impacts of alternative management decisions regarding marine protected areas, fishing regulations, recreation use, pollutants, and coastal development. NCCOS conducts a National Coral Reef Ecosystem Monitoring Grant Program to provide funding for cooperative agreements to support state and territorial coral reef monitoring

activities for: benthic habitat characterization; associated biological community structure, including fish and invertebrate conditions (abundance, density, size, diversity, disease, harvest trends, etc.).

The effort being proposed here will build on, enhance, and fill data gaps within the aforementioned knowledge already generated by efforts such as the NOAA PIFSC CRED RAMP and NCCOS programs.

- Explain the need for this activity and how it will help to enhance survival or recovery of refuge wildlife and habitats.

Coral reefs are hypothesized to be the most biologically diverse of all marine ecosystems (Paulay 1997, Reaka-Kudla 1997). Despite the fact that they occupy less than 0.2% of the ocean's area, coral reef ecosystems are estimated to provide habitats to about 25% of all marine species (Buddemeier et al., 2004). However, because of historical undersampling in tropical regions, estimates suggest that the number of species associated with coral reef ecosystems is not even known to the nearest order of magnitude. Reef coral species themselves constitute on the order of ~1000 species worldwide, but published estimates for reef associates range from ~1-10 million species (Reaka-Kudla 1997, Small et al. 1998). Unfortunately, these pioneering estimates, valuable as they are, are based on (1) extrapolations based on rain forest diversity (themselves debated) and (2) a partial count of the species in a coral reef aquarium in Baltimore. Individual reef systems likely host tens of thousands of species, and most of this diversity remains undocumented (Paulay 2003). Species new to science, including numerous possible endemics, are especially common on remote, isolated reefs that tend to be poorly explored. Field and molecular taxonomic scrutiny is showing that endemism on reefs is higher, and larval and genetic connections among them more limited, than previously suspected (Taylor & Hellberg 2003, Barber et al. 2000, and Meyer et al. 2005). In a paper recently published by the *Proceedings of the National Academy of Sciences* journal, International Census of Marine Microbes scientists reveal marine microbial diversity may be some 10 to 100 times more than expected, and the vast majority are previously unknown, low-abundance organisms theorized to play an important role in the marine environment as part of a "rare biosphere." According to lead author Mitchell L. Sogin, director of the Marine Biological Laboratory (MBL)'s Josephine Bay Paul Center for Comparative and Molecular Biology and Evolution, located in Woods Hole, Massachusetts, "These observations blow away all previous estimates of bacterial diversity in the ocean."

In addition to being poorly studied, coral reefs are also among the most imperiled and threatened marine ecosystems in the world. Significant declines in key indicators of reef ecosystem health suggest an unprecedented degradation of coral reefs around the globe in response to the combined effects of natural and anthropogenic stressors (Hughes et al. 2003, Pandolfi et al. 2003, Bellwood et al. 2005). There is clear danger that much reef biodiversity could be lost before it is even documented, and researchers will be left with a limited and poor understanding of undisturbed reef communities on which to base future management decisions. The recent rapid decline of remote reefs as a result of massive coral bleaching events and increased incidences of widespread disease makes recording their biota especially urgent. The observed increases in coral bleaching and diseases in recent years might suggest that coral reefs are particularly vulnerable to changing climate conditions, likely because of their high sensitivity to increasing water temperatures and CO_2 levels. In light of their high biodiversity and increasingly threatened status, coral reef ecosystems are an ideal candidate for the focused CoML project—Census of Coral Reefs (CReefs).

Specifically, with the information gathered on this cruise, we can begin to build a complete species list. A species list (knowledge of what exists) is a needed basis for the management of any area, and as it stands presently they are only nearly complete for the common, easily studied, larger plants and animals at any given location. This significant bias in research efforts is disproportionate to the impact even the smallest unknown species can have on an environment. Often, small species are responsible for considerable

changes throughout food-webs, incuding effects of parasites, bacterial diseases, bottom-up resource disturbances etc. This initiative will strive to identify rare and potentially vulnerable species that could eventually become threatened or endangered, thus paving the way for enhanced protection to insure their continued existence and the protection of the ecosystem in which they are involved. It is important to gain working knowledge of all species groups within a habitat to fully understand the processes that take place within it. Biodiversity is defined as the variability among living organisms on the earth, including the variability within and between species and within and between ecosystems. Defending biodiversity is critical to protected areas and directly in line with the goal of this effort: to begin to more accurately and thoroughly understand the biodiversity of coral reef ecosystems globally.

- Describe how your proposed project can help to better manage the State Marine Refuge.

The effort being proposed here will build on, enhance, and fill data gaps within already existing knowledge and investigations (and as previously mentioned much of this knowledge is currently funded to be made available in 2007 via PBIN and OBIS databases). This project will provide a detailed inventory of many of the lesser understood inhabitants in the State Marine Refuge, and the overlapping and contiguous jurisdictions of the Refuge and Monument, thus providing resource managers with information that is otherwise unavailable. A basic understanding of the diversity and distribution of these understudied coral reef species at French Frigate Shoals will provide managers with a more complete picture of the ecosystems to be managed and also a baseline for comparison throughout the Northwestern Hawaiian Islands, as well as for a global census of coral reefs (a CoML CReefs goal). With the information gathered on this cruise, we can begin to build a complete species list. As mentioned in the previous section, a species list (knowledge of what exists) is a needed basis for the management of these coral reef ecosystems, and species lists for the NWHI are currently focused on more highly studied species such as fish and corals, invertebrates on a limited macro level—leaving out the smaller, less understood species—the base of the food chain. In order to protect biodiversity, we must begin to more accurately and thoroughly understand the biodiversity of coral reef ecosystems here in our own backyard as well as globally. As the censuses continue on a global level, scientists will be able to provide managers of the State, Federal, and international marine protected areas with more information regarding patterns of species diversity for understudied reef associated groups over gradients of human disturbance, types/distribution of species obligately associated with healthy coral reefs, prospects for maintenance of species diversity on reefs suffering various levels of human impacts, and amounts/types of taxonomic and ecological information required to manage reefs effectively. Furthermore, though future investigations of this nature are not currently planned for FFS, we will have a much more complete species inventory from this effort--thus should the need arise and resources be made available, future (similar) investigations would not be discounted.

10. Procedures (include equipment/materials)

See continuation sheet below.

11. Funding sources (attach copies budget & funding sources).

Funding sources (see budget below)

This project is funded by the Sloan Foundation's Census of Marine Life, Census of Coral Reefs Project, with in-kind support from NOAA's Pacific Islands Fisheries Science Center and the Coral Reef Conservation Program, the Hawaii Institute of Marine Biology, the Florida Museum of Natural History, Scripps Institution of Oceanography, and the Natural History Museum of Los Angeles County.

Budget: Census of Marine Life Expenditures

Funding Source	Expenditure Type	Description	Amount
Pacific Islands Fisheries Science Center	Internal	Ship Time for the *Oscar Elton Sette*	$420,000
Pacific Islands Fisheries Science Center/NOAA Coral Reef Conservation Program	Internal	Salary for 2 personnel from CRED to participate and cruise prep for 3 months	$40,000
Pacific Islands Fisheries Science Center/NOAA Coral Reef Conservation Program	Internal	Supplies	$20,000
Sloan Foundation/Census of Marine Life/HIMB	Internal	Total 2 Year Budget for Census of Marine Life, Census of Coral Reef Ecosystems	$198,674
Florida Natural History Museum	In-Kind	Travel for 3 people to particpate in the cruise as well as and salary for cruise prep and data sorting for 3 months	$45,000
Scripps Institute of Oceanography	In-Kind	Travel for 1 person to particpate in the cruise as well as salary for cruise prep and data sorting for 3 months	$10,000
U.S. Fish and Wildlife Service	In-Kind	Salary for 1 person to participate in the cruise as well as cruise prep and data sorting for 3 months	$15,000
Los Angeles County Natural History Museum	In-Kind	Travel for 3 people to particpate in the cruise as well as and salary for cruise prep and data sorting for 3 months	$45,000
Coral Reef Ecosystem Reserve	In-Kind	Salary for 1 person to participate in the cruise as well as cruise prep for 2 months	$15,000
University of Guam	In-Kind	Travel for 1 person to particpate in the cruise as well as salary for cruise prep and data sorting for 3 months	$45,000
University of Hawaii	In-Kind	Salary for 2 personnel to participate in the cruise as well as cruise prep and data sorting for 3 months	$30,000
National Park Service	In-Kind	Travel for 1 person to participate in the cruise as well as salary for cruise prep for and data sorting for 3 months	$15,000
		Total	$898,674

12. List all literature cited in this application as well as all other publications relevant to the proposed project.

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13. What types of insurance do you have in place? (attach documentation)

NOAA Ship OSCAR ELTON SETTE is a U.S. Government-owned and –operated research vessel and is self-insured by the U.S. Government.

☐ Wreck Removal

☐ Pollution

14. What certifications/inspections do you have scheduled for your vessel? (attach documentation)

☐ Rat free ☒ tender vessel ☒ gear/equipment

☒ Hull inspection ☒ ballast water.

Vessels destined for operation within the NWHICRER will be inspected by Scott Godwin (HIMB) for the presence of marine alien species associated with the following mechanisms of transport.

1) Ballast Water
2) Hull Fouling-Primary Vessel and Tender Vessels
3) Scientific Equipment and Instrument Arrays

Standards for Compliance

Vessel Hulls, Scientific Equipment and Instrument Arrays
All surfaces must be free of macro-invertebrate fouling communities consisting of cnidarians (anemones and hydroids), arthropods (barnacles and other macro-crustaceans), annelids (mobile and tube dwelling worms), bryozoans, mollusks (clams, mussels, snails) and tunicates (sea squirts). Submerged surfaces must also be free of any Chlorophyta (green algae), Phaeophyta (brown algae) or Rhodophyta (red algae) macro-algae species. An inspection of the hull of the primary vessel will be conducted by an alien species specialist using SCUBA , while scientific gear and tender vessels will be inspected on deck. Inspections will take place prior to departure from Honolulu as well as FFS.

Ballast Water
The vessel must have a US Coast Guard and/or International Maritime Organization ballast water management plan on board. The records of ballast water operation for the previous month must be available for inspection. If concerns exist it will be necessary to access saltwater ballast tanks to conduct plankton sampling.

Tender Vessel Preparation
Before departure, all tender vessels will be washed and inspected for alien terrestrial and aquatic species. All gear will be soaked in 100% fresh water for 24 hours. Care is taken to open all pockets and zippered compartments before soaking in fresh water.

15. Other permits (list and attach documentation of all other required Federal or State permits).

The NOAA ship SETTE's has a USFWS permit # 12521-06012.
NOAA's PIFSC has pending Special Use Permit applications before the U.S. Fish and Wildlife Service to support these activities.

16. Project's relationship to other research projects within the NWHI State Marine Refuge, National Wildlife Refuge, NWHI Coral Reef Ecosystem Reserve, or elsewhere.

The project supplements the annual Reef Assessment and Monitoring Program (RAMP) cruises conducted under the auspices of the NOAA Coral Reef Conservation Program, HIMB and Bishop Museum research, as well as future Census of Coral Reefs research and will provide biodiversity information critical to the global CoML Census of Coral Reefs project.

Section C: Logistics	
17. Time Frame:	
Project Start Date October 3, 2006 (approx.)	Project Completion Date October 25, 2006 (approx.)
Dates actively inside the State Marine Refuge. October 3 to 25, 2006 (Subject to change)	

Personnel schedule in the State Marine Refuge (describe who will be where and when).

Entire ships complement will be within the refuge on the specified dates. See below.(Participants subject to change)

#	Participants	Affiliation	Email
1	**Rusty Brainard**	Chief, CRED NOAA/PI CReefs	Rusty.Brainard@noaa.gov
2	**Amy Hall**	CRED JIMAR	Amy.Hall@noaa.gov
3	**Brian Zgliczynski**	CRED NOAA	Brian.Zgliczynski@noaa.gov
4	**Jim Maragos**	USFWS	Jim_Maragos@fws.gov
5	**Laetitia Plaisance**	Scripps Institution of Oceanography	lplaisance@ucsd.edu
6	**Andy Collins**	NWHI Marine National Monument	Andy.Collins@noaa.gov
7	**Leslie Harris**	Natural History Museum of LA County	lharris@nhm.org
8	**Jody Martin**	Natural History Museum of LA County	jmartin@nhm.org
9	**Sea McKeon?**	Florida Museum of Natural History	cmckeon@zoo.ufl.edu
10	**Gustav Paulay**	Florida Museum of Natural History	paulay@flmnh.ufl.edu
11	**John Starmer**	Florida Museum of Natural History	eucidaris@gmail.com
12	**Elizabeth Keenan**	CRED JIMAR	Elizabeth.Keenan@noaa.gov
13	**Cory Pitman**	Private/Federal Volunteer	cory@cet.com
14	**Scott Godwin**	HIMB/Bishop	sgodwin@bishopmuseum.org
15	**Kristopher Coontz**	UH-Botany	kriscoontz@hotmail.com
16	**Rebecca Most**	Kaloko Honokohau National Historical Park	Rebecca_Most@nps.gov
17	**Erik Franklin**	HIMB	Erik.Franklin@noaa.gov
18	**Susan Middleton**	Outreach photographer	s_middleton@igc.org
19	**TBD**	Scientist/Outreach	
20	**TBD**	Chamber Operator	

Alternates currently include: Tito Lotufo, ascidians specialist, Brazil; CoML ICOMM microbes expert TBD, Russell Hill, sponge microbe specialist

18. Gear and Materials

☒ Dive equipment ☐ Radio Isotopes

☒ Collecting Equipment ☒ Chemicals (specify types)

Chemicals to be used onboard the *Oscar Elton Sette* only:
95% Ethanol
Formalin
Magnesium Chloride
Chloretone
Menthol Crystals

19. Fixed installations and instrumentation.

☐ Transect markers ☐ Acoustic receivers

☒ Other (specify) Artificial Reef Matrix Structures (description located in #10 under Procedures)

20. Provide a time line for sample analysis, data analysis, write-up and publication of information.

Sample processing and analysis will take place onboard the ship and following the cruise (see previous sections for greater detail). Data from the cruise will then be provided directly to NBII's Pacific Basin Information Node and the international Ocean Biogeographic Information System, available to managers and the public. A report of all activities carried out under the permit authority will be submitted to the DLNR, NOAA, and the USFWS within 60 days of the conclusion of the mission. The report will include the dates of all arrivals and departures from islands and atolls within the Refuges and Monument, names of all persons involved, and a description of the work performed. Further reports can be made available to the granting agencies upon request.

21. **Vessel Information**:

Vessel Name NOAA Ship OSCAR ELTON SETTE IMO Number 8835097

Vessel Owner US Department of Commerce, NOAA Flag U.S.A.

Captain's Name LCDR Karl Mangels Chief Scientist or Project Leader Russsel E. Brainard

Vessel Type Oceanographic research Call sign WTEE

Length 68.3 m. Gross tonnage 2,014

Port of Embarkation Honolulu

Last port vessel will have been at prior to this embarkation Honolulu, HI

Total Ballast Water Capacity: Volume 135,000 gal Total number of tanks on ship 10

Total Fuel Capacity: 163,000 gal Total number of fuel tanks on ship 14

Other fuel/chemicals to be carried on board and amounts:

Gasoline: up to 700 gal
Lube Oil: up to 100 gal (no lube oil tanks)
Gasoline: up to 700 gal
Lube Oil: up to 100 gal (no lube oil tanks)
95% Ethanol (3-55gallon drums)
Formalin (10-15L)
Magnesium Chloride (2000mg)
Chloretone
Menthol Crystals (<70mg)
Clove Oil (100ml)
RNA (4L)

Liquid Nitrogen

Number of tenders/skiffs aboard and specific type of motors:

Ship's own tenders:
1 each 15 ft SAFE Boat with Honda 90-hp outboard engines
1 each 16 ft Achilles inflatable boat with Honda 40-hp outboard engine
1 each 18 ft AMBAR Marine rescue boat with twin Mariner outboard engines

PIFSC-provided tenders:
1 each 19 ft SAFE boat with twin Honda 75-hp outboard engines
1 each 19 ft SAFE boat with twin Yamaha 60-hp outboard engines

Does the vessel have the capability to hold sewage and grey-water? Describe in detail.

6000 gal holding tank for grey & black water.

Does the vessel have a night-time light protocol for use in the NWHI? Describe in detail (attach additional pages as necessary)

No

On what workboats (tenders) will personnel, gear and materials be transported within the State Marine Refuge?

The tenders listed above will be used to transport gear and materials within the Refuge.

How will personnel, gear and materials be transported between ship and shore?

The workboats and tenders described above will be used to transport personnel, equipment, and samples to and from shore, should this be needed. Work to be performed ashore would include specimen sorting and analysis on Tern Island—should this be needed, permits will be sought out as soon as possible.

If applicable, how will personnel be transported between islands within any one atoll?

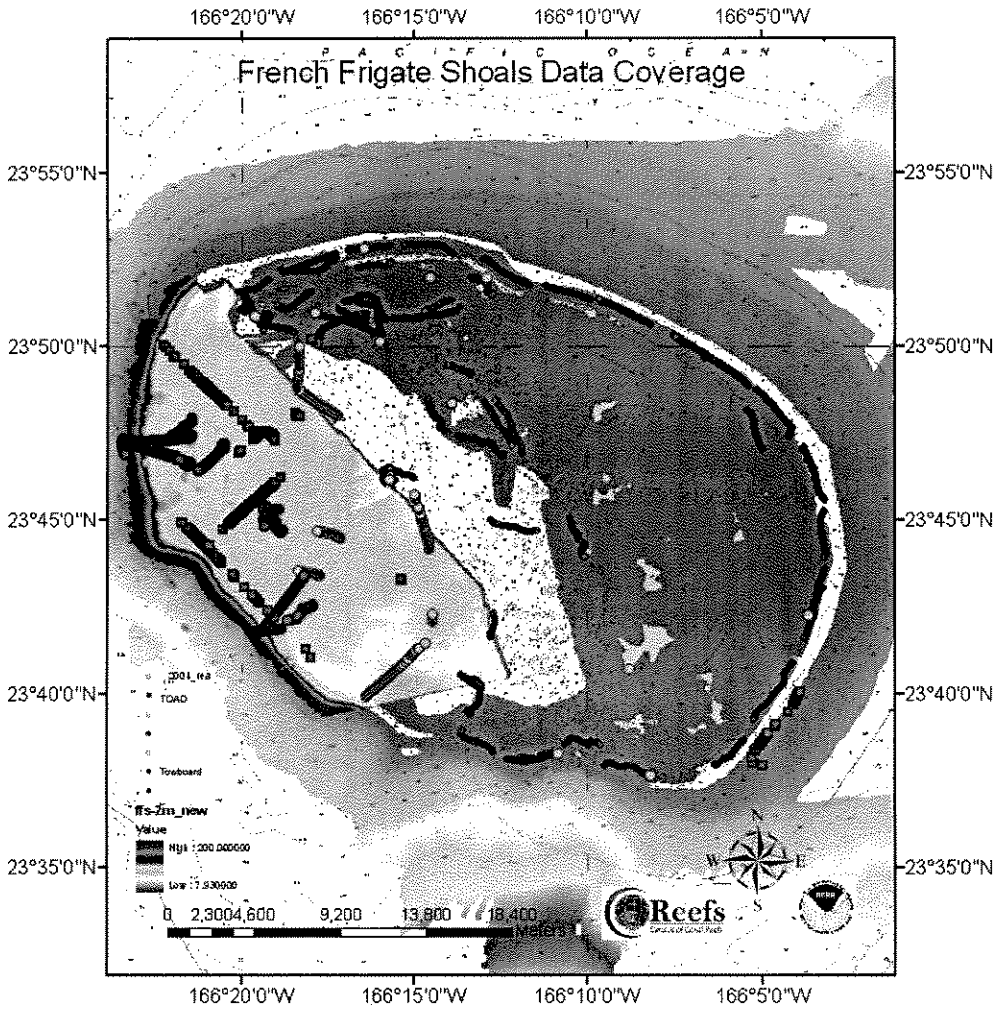
Transporting personnel between islands within any one atoll is not a routine operation. If required, the workboats and tenders described above will be used.

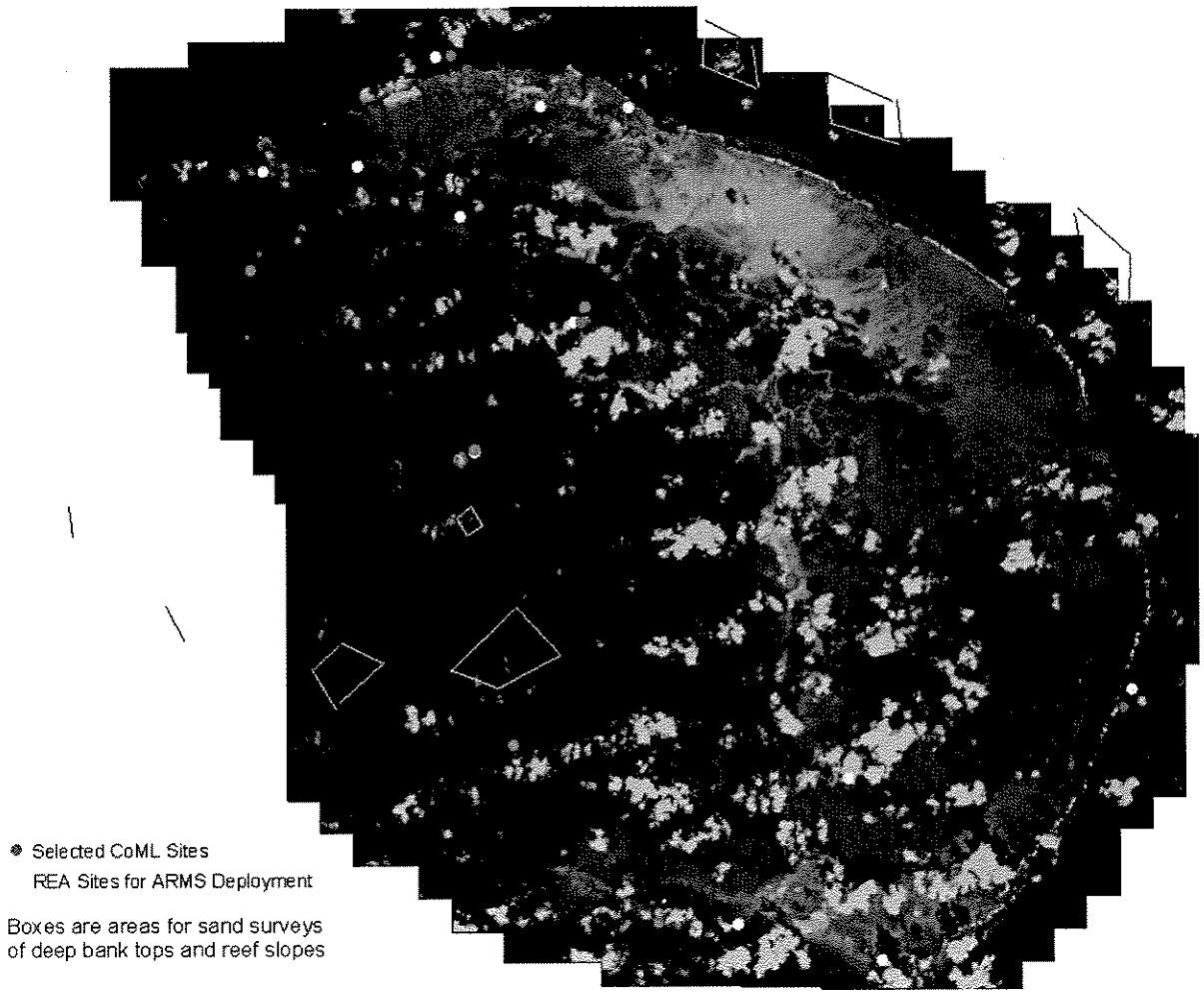
Procedures

The diversity of marine invertebrates, algal and microbial communities and their habitats necessitates a broad and diverse array of collecting techniques. Needs regarding target species, specific habitats, and sampling methods have been thoroughly discussed and prioritized by taxonomic experts as well as managers in numerous workshops, meetings and conference calls in order to plan this effort with the utmost efficiency. The planned techniques have proven successful in other taxonomic research efforts throughout the world (see references section). For the majority of the procedures listed below, we will survey 2-3 stations at each habitat type listed here with three replicates per station: the forereef (5, 10, & 25m), the reef crest (0-1m), the back reef (1m), intertidal shores (0-1m), lagoon sand (5-10m), lagoon patch reef (5-10m), deep bank tops (30-100m), deep reef slopes (50-200m), as well as idiosyncratic habitats such as La Perouse, arc shell reefs, Acropora areas, and Halimeda fields. All procedures will be conducted via snorkeling, SCUBA, small boat operations, and ship-based support and the total area covered in this sampling effort will be minimal in comparison to the overall size of the atoll.

Site Selection

In order to make informed and careful decisions regarding locations for sampling, we have consulted IKONOS (satellite) imagery, high resolution bathymetric and backscatter data (to investigate complexity and bottom type), video ground truthing data, and other towed diver benthic surveys and Rapid Ecological Assessment survey data collected during CRED RAMP cruises, as well as multiple scientists familiar with these datasets, areas within FFS, and the protocols. We will be able to use this information to select sites for deployment of instruments as well (for example, locating sand areas for deployment of baited traps). While many of the sites selected are in proximity to the REA sites, we have placed them at a minimum of 500 meters away from the REA sites, so-as not to interfere with annual assessment and monitoring. The datasets mentioned here and/or significant information from them will be taken on the cruise for reference and to assist in planning daily operations. Attached are maps demonstrating the types of datasets we are able to work from as well as the sites (primary and alternate) that we plan to focus on. We have included a list of alternate sites in case weather and/or sea conditions will not permit a safe working environment at the planned primary sites. See attached maps.


French Frigate Shoals Data Coverage
166°20'0"W
166°15'0"W
166°10'0"W
166°5'0"W
23°55'0"N
23°50'0"N
23°45'0"N
23°40'0"N
23°35'0"N
TOAD
Towboard
ffs-2m_new
Value
0 2,3004,600 9,200 13,800 18,400
Meters
Reefs



REA Sites		
Site	Latitude (Decimal Degrees)	Longitude
H6	23.8805	-166.2737
21	23.8479	-166.3264
23	23.8669	-166.2418
R4	23.7694	-166.261
32	23.8063	-166.2309
33	23.8358	-166.266
R3	23.8666	-166.214
30	23.8496	-166.2973
34	23.6278	-166.1358
12	23.6378	-166.18
R2	23.6785	-166.146
25	23.7042	-166.061

CoML Sites		
Site ID	Latitude (Degrees Minutes Seconds)	Longitude
FR 1	23,52.84320	166,16.14220
FR 2	23,41.93680	166,03.80812
FR 3	23,38.30190	166,12.24100
RC 1	23,51.72480	166,12.67070
RC 2	23,52.43920	166,13.94100
RC 3	23,52.35760	166,16.02620
BR 1	23,51.58640	166,12.76120
BR 2	23,52.22290	166,14.03270
BR 3	23,52.42360	166,15.86270
IS 1	23,46.21800	166,15.66210
IS 2	23,51.79790	166,13.27870
IS 3	23,44.77380	166,10.19260
LS 1	23,47.29980	166,12.44030
LS 2	23,44.43160	166,9.838310
LS 3	23,48.49660	166,13.73980
LPR 1	23,48.3890	166,13.71530
LPR 2	23,49.2123	166,19.78660
LPR 3	23,41.2374	166,14.91570

Techniques

The variety of techniques described in this section are a necessity for collecting a broad spectrum of organisms that live in a variety of habitats. Within the various habitats there will be representatives from marine invertebrate phyla that dwell as mobile or sessile epifuana or infauna, algae, and organisms within the water column. Each technique will be qualified by the habitat(s) it targets and the organism types that will likely be collected. Reef sites will be surveyed using a combination of the following techniques: hand collecting, rubble extraction, rubble brushing, suction, cryptofauna analysis, algal and microbial techniques and the Artificial Reef Matrix Structures (ARMS). The soft bottom and lagoonal sand sites will be surveyed using hand collecting, sand sampling, the scoop, the Yabbie pump, mobile epifauna traps, and the Ekman (or Van Veen) grab. The water column will be sampled using the light traps and plankton nets. A GPS position and before/after photograph will be taken at each site.

Once onboard the ship, each invertebrate organism will be preserved in 95% ethanol. Note: no chemicals will be used in the small boats or in the water—only on the platform vessel. Each organism's associated data will be documented into an electronic spreadsheet and input directly into a database including but not limited to the following information: collector, taxonomic confirmation, date, georeference coordinates, photograph etc. For barcoding, tissue samples will be taken on 1500-2000 of the species that have been sorted to morpho species, with one to two replicates each--DNA from these poorly understood species will be used in barcoding studies to help future researchers identify taxonomically challenging taxa. Sub-sampling will take place while the scientists are still in the field (on the ship) to make it easier for further barcoding. Barcode sequences will be submitted to GenBank and the Barcode of Life Initiative. As mentioned previously, the data from this effort will also be

submitted to the Moorea Biocode, PBIN and OBIS databases. As stated in the State of Hawaii's DLNR permit guidelines for access to the NWHI, **the samples collected are a public trust and will NOT be used for bio-prospecting, sale, bioassay, patent, obtaining patents or intellectual property rights.** The species collected will be housed in museums and with the agencies conducting the analyses, available to public inquiry. Furthermore, all participants will be required to sign that they have read and will abide by the conditions put forth in this permit.

Definitions:

Epifauna- Organisms living on a surface that can either be mobile or permanently attached (sessile)
Infauna- Organisms that live under the surface of submerged sediments.
Plankton- Organisms that exist in the water column either permanently or temporarily.

The following table provides a general breakdown of the proposed operations, more information on these techniques follows.

Sampling Method	Target Habitat	Target Organisms	Brief Description (See Protocols for more detail)
Hand Collecting	All proposed habitats	Sessile/Mobile Epifauna; sponge communities	Animals are taken by hand, placed in bags or jars with ample seawater, and taken shipboard lab for study.
Rubble Extraction	All proposed habitats	Motile Cryptic Invertebrates	Pieces of loose rubble (in the ~20-40cm range) gathered underwater from a small area are placed in a plastic-lined mesh bag. The sample is recovered by a diver using a lift bag, or from a boat using a line and float tethered to the bag. A total of 2-3 buckets worth collected per day.
Rubble Brushing	Fore reef, Reef Crest, Back reef, Lagoon Patch Reef, Intertidal Shores, La Perouse, Ark Shell Reefs	Mobile Epifauna	Coral rubble is held over a basket lined with a fine screen and gently brushed with a soft brush, so that animals fall/swim off the rubble into the basket. After brushing, the rubble is replaced on the bottom in the same position that it was found. Aprox. 3-5m2 area brushed per site, yielding <100ml of tiny organisms.

Sand Sampling	Lagoonal sands	Mobile Epifauna, Infauna	We will target both live and dead components of the sand fauna. Live components will be collected by sieving 15 gallons of reef sand per site over 1mm mesh screen underwater, with only the retained fraction taken on board for sorting. For the study of death assemblages of skeletonized taxa (principally mollusks, although forams, ostracods)2 liters of sand is collected, washed with freshwater and air-dried.
Plankton Nets	Water column, fore reef, lagoonal	Plankton	Subsurface tows with a 1 m diameter, 100 um net to sample local plankton at 5 fore reef and 5 lagoonal sites.
Artificial Reef Matrix Structures (ARMS)	Forereef, Backreef, Lagoonal Patch Reef	Sessile and Mobile Epifauna	ARMS are small, long-term collecting devices designed to mimic, to some degree, the structural complexity of a coral reef, thus attracting colonizing invertebrates while remaining in the field.
Light Traps	Water column	Planktonic larvae and adults	We will use a simple design that consists of a black PVC body with four openings lined by plastic funnels. Larvae and other zooplankton enter a wide end of the funnel and are trapped within the PVC body.
Yabbie Pump	Lagoonal sands and Intertidal shores, La Perouse, Arc shell reefs, Acropora areas	Infauna and Burrowing Epifauana	The yabbie pump is a simple stainless steel hand operated suction device that extracts burrowing organisms/ their commensals.
Baited Traps	Lagoonal sands	Mobile Epifauna	Baited traps (standard commercial style Fathoms Plus polyethylene plastic traps) will be baited with 1 kg of mackerel and soaked overnight at depths of 30-300 meters.
Ekman Grab (or Van Veen Grab)	Lagoonal Sand, Deep sand (>30m depth)	Infaunal Organisms	Sampling soft bottomed substrate, the grab is lowered from a boat--two hinged upper lids swing open to let water pass through and close upon retrieval on the substrate preventing sample washout. Three grabs per site, yielding average 10 macrofauna and 2 liters of sand per site.
Microbial Collections	Water column, sediment	microbes	Non-invasive techniques will be used to sample the water column and sediment.
Algal Collections	Forereef, Backreef, Reef Crest, Lagoon Patch Reef, La Perouse, Arc shell reefs, Acropora areas, Halimeda Fields	Macro, Turf, and Coralline Algae; macro/meso fauna	A representative of each algal (macro, turf, and coralline) species will be hand collected at each site and brought back to the ship for identification and analysis.
Suction	Forereef, Backreef, Reef Crest, Lagoon Patch Reef	Cryptic epifauna	A vacuum-type device will be used to suction samples, which involves lifting small organisms from hard bottoms through suction generated by compressed air into a 2-4 inch diameter pipe. The gentle current created lifts small, mobile organisms into the pipe, capturing them in a mesh bag tied to the end of the pipe. Less then 3-5m2 area effected per site.
Cryptofauna Analysis	Forereef, Reef Crest, Backreef	Cryptic epifauna	A total of 10 rubble *Pocillopora sp.* will be collected over the course of the cruise, the invertebrates will be extracted and the rubble returned to the water.

Scoop	Deep Sand, Lagoonal sand	Infauna and epifauna	To obtain small invertebrates from sandy areas at ~ 100 m depth, the scoop will be towed by the ship or a small boat at an approximate speed of 2 knots along transects 500 -1000m in length.

Hand collecting

Lead Scientist: Scott Godwin
Target Habitats: All proposed habitats including Forereef, Reef Crest, Backreef, Intertidal Shores, Lagoonal Sands, Lagoonal Patch Reef, La Perouse, Arc shell reefs, Acropora areas
Target Organisms: Sessile and mobile epifauna; macrosponge communities
Quantities:

This is the most general method employed by invertebrate zoologists for the collection of macrofauna. Animals are taken by hand, placed in bags or jars with ample seawater, and taken to the shipboard lab for study. Many species are simply taken from the reef surface; others are taken from under rubble. For the latter, loose pieces of coral rubble are gently lifted, targeted specimens secured, and the rubble replaced in the same position as it was found to cause minimal disturbance to other organisms. One example demonstrating the efficiency of this method is that of sponge and opisthobranch fauna hand collected in Guam. (see Kelly et al., 2003; Carlson & Hoff, 2003)
A component of the reef biota lives exclusively on sponges, and the numerous organisms occurring on and inside marine sponges have been described as "an ecological community, in which, however, interrelationships are not yet clear" (Westiga and Hoetjes 1981). Neither is their systematics or their host specificity well understood. In order to observe and collect them, subsamples of tissue are removed from the macrosponges that have been collected for identification. The pieces of sponge are collected in mesh bags, maintained in running seawater in the laboratory, and dissected to remove associated animals.

Rubble Extraction

Lead Scientist: Gustav Paulay
Target Habitats: All proposed habitats including Forereef, Reef Crest, Backreef, Intertidal Shores, Lagoonal Sands, Lagoonal Patch Reef, La Perouse, Arc shell reefs, Acropora areas
Target Organisms: motile, cryptic invertebrates

Most reef animals are motile, cryptic invertebrates, which dwell within the fabric of the reef in rock, algae, and sediment. Relatively few emerge nocturnally and are visible during night dives. The majority of the fauna remains hidden from view. Furthermore, species living meters deep in reef framework are virtually inaccessible, short of dismantling reef structures. Therefore, the extraction of invertebrates from rubble is indispensable as a proxy for the destruction of hard substrate that would otherwise be necessary to sample hard bottom biodiversity. Rubble extraction is a standard means used to survey coral reef biodiversity, and can be applied in a qualitative or a quantitative fashion. Pieces of rubble gathered underwater from a small area are placed in a plastic-lined mesh bag to prevent the escape of small organisms. The bagged sample is recovered by a diver using a lift bag, or from a boat using a line and float tethered to the bag. On the surface, pieces of rubble are maintained in running seawater, cracked to remove boring fauna, held under mildly anoxic conditions, and then treated with reagents such as fresh water or dilute formalin to expel resident invertebrates. After each step of the

treatment the rubble is washed and the seawater is decanted and sieved in order to collect the additional animals. The cleaned rubble may be returned to the reef.

Rubble Brushing

Lead Scientist: Gustav Paulay
Target Habitat: Forereef, Reef Crest, Backreef, Lagoonal Patch Reef, Intertidal Shoreline, La Perouse, Arc shell reefs
Target Organisms: Mobile epifauna

Brushing coral rubble is an effective method for collecting small invertebrates that are either difficult to see because they are cryptic or small, or are more efficiently collected by brushing, because they are numerous. Coral rubble is held over a basket lined with a fine screen and gently brushed with a soft brush, so that animals fall/swim off the rubble into the basket. After brushing, the rubble is replaced on the bottom in the same position that it was found. Rubble brushing is one of the most productive methods for collecting invertebrates in the 1-10mm size range. In sites without loose rubble, a surface area of no more than 50 square meters may be lightly brushed and the small animals that are dislodged collected by sweeping with a 15 cm diameter, 1/4 mm mesh net. Typically, such sampling results in collection of less than 1/4 liter of dislodged algal fragments and results in minimal disturbance to the bottom. In some cases, sweeping with a fine mesh net may also be substituted for the basket while brushing rubble.

Sand sampling

Lead Scientist: Russell Brainard, Scott Godwin
Target Habitats: Lagoonal sands
Target Organisms: Mobile epifauna, Infauna

Mobile sediments dominate large atoll ecosystems like French Frigate Shoals, as they comprise much of the lagoon bottom. Reef sands hold diverse epi- and in-fauna, and also accumulate the skeletal remains of taxa that live on hard reef bottoms. We will target both live and dead components of the sand fauna. Live components will be collected by sieving 15 gallons of reef sand per lagoonal sand site over 1mm mesh screen underwater, with only the retained fraction taken on board for sorting. For the study of death assemblages of skeletonized taxa (principally mollusks, although forams, ostracods, and other taxa could also be studied if future interest and expertise permit) 2 liters of sand per site (for a total of 12 liters) will be collected in a plastic bag, washed with freshwater and air-dried. Shells will be picked by first sieving the sample into size fractions to facilitate sorting, then picking proportionately across size fractions, until 500 mollusk shells have been picked. These quantitative samples permit rigorous comparisons of mollusk biodiversity among habitats and sites (see Peshut, 2000), and can be the most productive technique for documenting the diversity of primarily infaunal taxa, such as bivalve mollusks (Paulay, 2003). The remainder of the samples collected to study death assemblages will be examined, as time permits, to compile a qualitative list of the relevant taxa. The sand from the field screening that remains after removal of live animals may also be retained for these purposes.

Plankton Nets

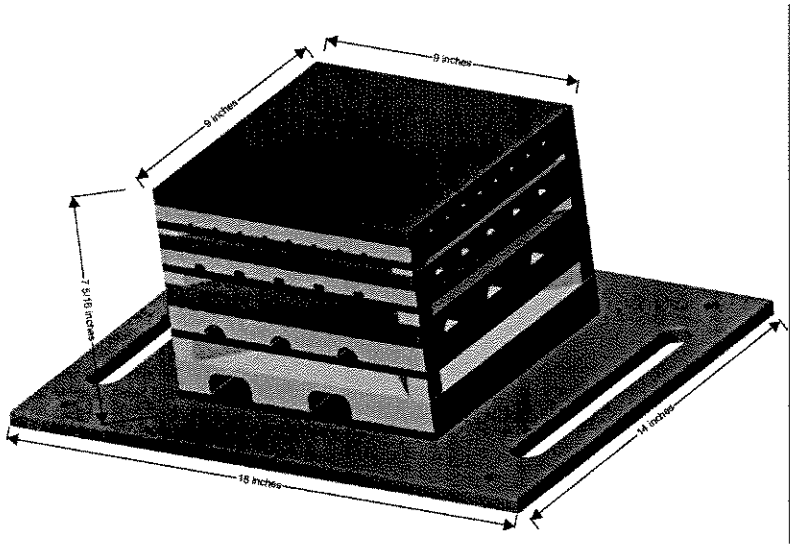
Lead Scientist: Scott Godwin, Gustav Paulay
Target Habitat: water column--fore reef, lagoonal
Target Organisms: plankton

Plankton nets sample plankton communities. We propose to do 10 subsurface tows with a 1 m diameter, 100 um net to sample local plankton at 5 fore reef and 5 lagoonal sites. Collected plankton samples will be divided in half, half fixed in formalin for morphological study and half fixed in 95% ethanol. Plankton includes taxa that spend their entire life in the water column (holoplankton), as well as the larval stages of benthic species (meroplankton). DNA barcoding techniques provide a novel method for matching
planktonic larval and benthic adult stages. Barcoding plankton samples will also allow us to estimate what percentage of the benthic fauna were successfully sampled by providing an independent estimate of that fauna in their larval stages: thus the proportion of meroplankter sequences encountered that are not represented in the benthos is an indication of how incomplete benthic sampling has been.

Artificial Reef Matrix Structures (ARMS)

Lead Scientist: Joel Martin, Russell Brainard
Target Habitats: Forereef, Backreef, Lagoonal Patch Reef
Target Organisms: Sessile and mobile epifauna

ARMS are small, long-term collecting devices designed to mimic, to some degree, the structural complexity of a coral reef, thus attracting colonizing invertebrates and fishes over the period during which the ARMS are left in the field. The term ARMS was coined by Zimmerman and Martin (2004) in a paper describing how they are constructed, deployed, and harvested. The original design involved several layers of concrete with different sized openings and a variety of microhabitats to allow different occupants to colonize the structure. This design also included a mesh basket suspended from a PVC frame; the basket contained coral rubble and was set flush with the surrounding substrate, the idea being that any escaping invertebrates would flee the ARMS only to be caught in the underlying basket (Zimmerman & Martin 2004; Martin 2002). We will be deploying a similar device, but with a much less complicated construction, made of PVC, in order to avoid over-collecting and will not include a rubble basket. Each of the ARMS will be 14" x 18" x 8". Layers (9"x9") include flat sandwich and layers with holes of varying sizes ranging from 3/4" to 3/32" in diameter. The design, shape and size of the ARMs are such that they and their deployment, pose no threat to monk seals or turtles. A total of 12 ARMS will be deployed at three separate habitat types in three different ecozones (Vroom 2005) in FFS. Three replicates will be deployed at each site of the same depth and habitat type (fore reef 10-25 m to avoid threats associated with the wave base). These deployment sites will be associated with CRED's already established REA sites from the Reef Assessment and Monitoring Program. To compare the biota of other habitats, 2 each will be deployed at two lagoon patch reef sites, plus 1 each at two back reef sites. They will be placed on pavement or sand, in proximity to coral reef structures, specifically to avoid coral damage. The ARMS will be deployed by CRED working divers using lift bags and will be installed using stainless steel stakes and/or weights to insure that they remain in place at French Frigate Shoals for the duration of 1-2 years. A GPS point will be taken for each of the ARMS and subsurface floats will be attached one meter above to facilitate diver location when the ARMS are to be picked up. The Coral Reef Ecosystem Division of the Pacific Islands Fisheries Science Center will be responsible for maintaining and removing the installations during a follow-up NWHI RAMP cruise.



Artificial Reef Matrix Structure (ARMS)

Light Traps

Lead Scientist: Russell Brainard
Target Habitat: Water column
Target Organisms: Planktonic larvae and adults

"Light traps" of various designs have been used for years to collect marine fishes and invertebrates, especially their larvae and other zooplankton at night. Target taxa will include various planktonic crustaceans such as mysids, cumaceans, isopods, as well as marine worms (should small fish get caught, there will be little chance of mortality and they will be released). Many planktonic organisms navigate by and are attracted to light, and this method takes advantage of that fact. Light traps can be deployed by tying them to any other structure that is going to be in the water at night or they can have their own bottom weight. The light traps will either be attached to the ship or deployed by divers for careful placement of the light trap anchors. The traps themselves will not be on the bottom. It is best that they hang in the water column just below the surface. They will need to be deployed for only a couple of hours at a time after sunset. The organisms they are intended to catch will be in the upper meter or so of the water after dark, and usually for only a few hours. Although a large variety of designs have been used successfully over the years, we will use a simple and commercially available design that consists of a black PVC body with four openings lined by plastic funnels. Plankton enter via the wide end of the funnel and become trapped within the PVC body. Lighting is achieved by inserting either disposable cyalume "light sticks" or a small underwater flashlight into the trap. "Aquatic Light Trap" have been used successfully in the Caribbean. (Doherty 1987; Holmes & O'Connor 1988; Watson, et. al 2002)

Yabbie Pump

Lead Scientist: Joel Martin
Target Habitat: Lagoonal sands and Intertidal shores, La Perouse, Arc shell reefs, Acropora areas
Target Organisms: Infauna and burrowing epifauana

The yabbie pump, used in burrows, is a simple stainless steel suction device that is hand operated and used to extract burrowing organisms along with their commensals. It consists of an external steel cylinder approximately 1 meter in length, within which is a long steel rod with a plunger on the downstream end that seals against the sides of the cylinder with a rubber gasket. When the opening of the cylinder is placed against the opening of burrow, the operator pulls the handle of the plunger rapidly upward, creating a suction that removes the contents of the burrow. The contents (including mud and sand) are then pushed back out by the plunger into a sieve for examination (Hailstone 1962; Manning 1975; Manning & Felder 1986).

Baited Epifauna Traps

Lead Scientist: Scott Godwin/Rusty Brainard
Target Habitat: Lagoonal sands
Target Organisms: Mobile epifauna
Quantities: Maximum of 5 single (shallow) traps and 24 (deep) traps per night

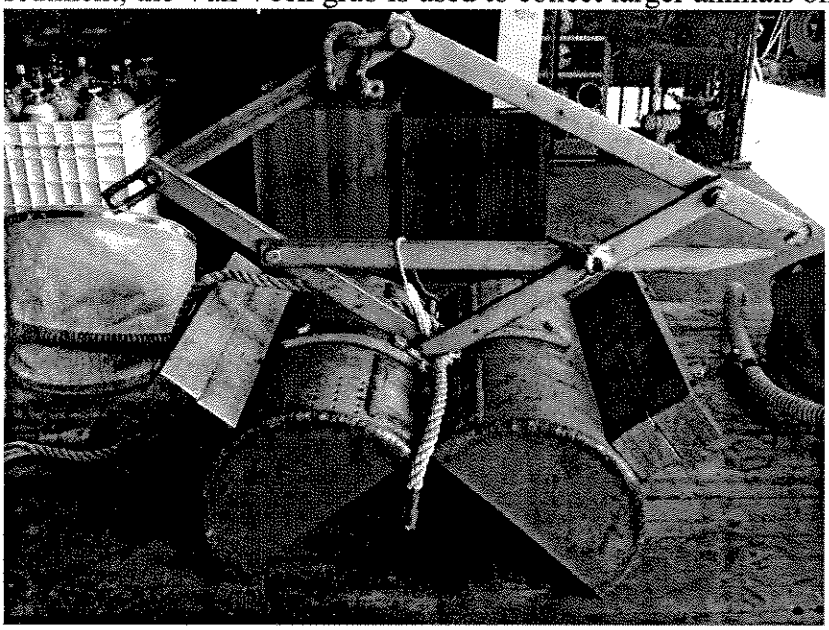
Three strings with eight lobster-type traps (standard commercial style Fathoms Plus polyethylene plastic traps), as well as 5 single traps, will be baited (following official standards for frozen bait) and soaked overnight at a depth of 30-300 meters. Each trap on the string will be separated by groundline, and the first trap in each string will be connected to a floatline with an inflatable buoy and a hard buoy attached. The single traps, being deployed at the shallower depths will be hand-placed by divers. All traps will have encapsulated lead inside to weight them down. A minnow trap will be placed in each trap for the purpose of capturing organisms smaller than the mesh of the trap, such as crabs, shrimp and snails. The traps will be placed in sandy areas located by means of bathymetric, backscatter, and video data. To prevent non-target organisms such as the lobsters *Panulirus marginatus* and *Panulirus penicillatus* from entering the traps, we will attach tie wraps or the equivalent across the openings of the traps, making the openings smaller. Should non target organisms such as the Triton's Trumpet *Charonia tritonis* or Horned Helmet Shell *Cassis cornuta* be found in the traps, they will be culled from the traps immediately after retrieval and released. Prior to field deployment, the traps will be soaked, cleaned, disinfected.

Ekman/Van Veen Grab

Lead Scientist: Gustav Paulay
Target Habitat: Lagoonal sands
Target Organisms: Infaunal organisms

The Bottom Grab sampler is designed for sampling in soft bottomed substrate. It is particularly ideal for slow moving or sedentary species. As the sampler is lowered from the boat, two hinged upper lids swing open to let water pass through and close upon retrieval on the substrate preventing sample washout. The grab we will use is 12 inches long, 8 inches wide and cylindrically shaped. It will be used at depths of approximately 30meters and deeper. It will retrieve a sample of a given surface area of benthic substrate and the organisms on and within that substrate. The advantage of a grab is that it can be deployed and retrieved quickly, bringing up a small amount of sediment and getting a perfect sample with very little bottom disturbance. From this, sand sampling can be done, providing samples with distinct fauna from deeper depths. This method of sampling is an extension of the previously

described sand sampling and will be used to reach sand habitats that are beyond SCUBA depths. If we are able to obtain one, in place of the Ekman grab, we would prefer to use the Van Veen grab. While the Ekman grab would be useful for taking very small samples of minute animals from extremely fine sediment, the Van Veen grab is used to collect larger animals on sandy sediment in deep water.



Ekman Grab

Microbial Collections

Lead Scientist: Russell Brainard, Emmanuel Irizarry Soto
Target Habitat: water, sediment
Target Organisms: Microbes
Sample size/Quantity: n=3

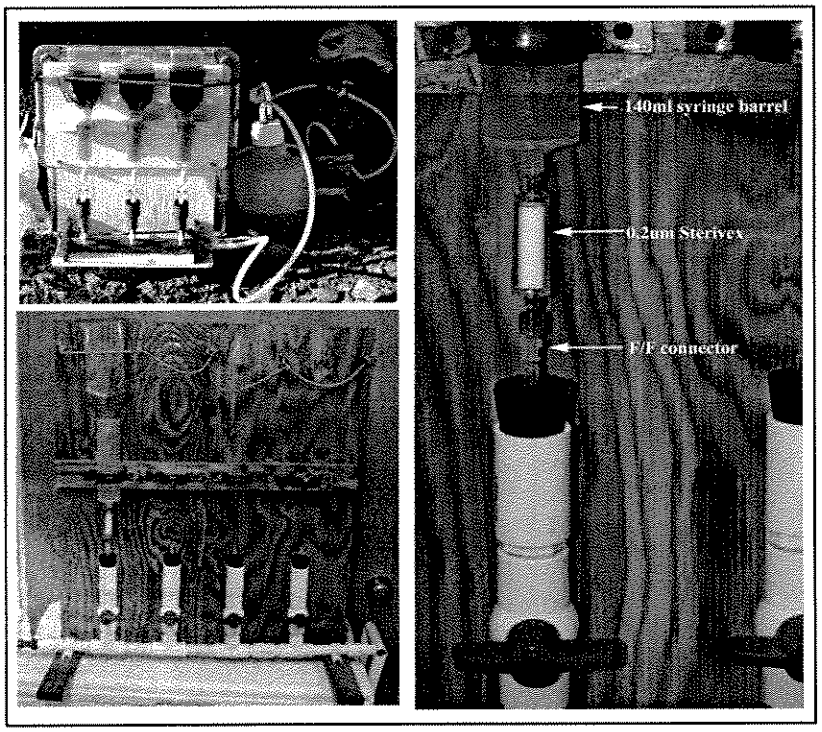
Water and sediment samples will be taken for RNA/DNA work by means of extremely non-invasive procedures, following the CoML International Census of Marine Microbes (ICoMM) protocols.

Sampling waters for lipid analyses of water
For lipid analysis 20-100 liters of water, depending on cell densities, needs to be filtered over pre-combusted (400°C, overnight) 0.7 µm glass fiber filters (GFF). The filters are then packed in aluminum foil (the use of soft plastic should be minimized) and kept frozen in the dark. Before analysis the filters are freeze-dried.

Lipid analyses of sediment
Sediment samples can be taken by a variety of techniques including box coring and piston coring. Samples can be taken from the core by metal sampling devices (e.g. spatulas) and should be 1-10 gram in size depending on organic matter contents (e.g. for 1% OC, 100 mg of sample may already be enough). The samples can be stored frozen or freeze-dried and subsequently stored frozen in the dark, preferably in hard plastic bottles or special geochemical bags.

Sampling water for DNA/RNA extraction using a Sterivex filter
Sterivex filters are 0.22 micron capsules (Millipore) that are routinely use by ICoMM scientists concentrating water samples for further DNA or RNA sample extraction. The traditional application involves filtering a recorded volume of water through the filter using a sterile syringe (140 or 60 cc). The sterivex is then either kept frozen until further processing or else a room temperature stable buffer

(such as the Puregene Lysis Buffer (Gentra Systems) or RNAlater (Ambion) is added to fill the sterivex chamber (~2 ml) and the unit is then refrigerated, frozen or shipped to its final destination. While the buffers added to the chamber are stable at room temperature and will prevent DNA/RNA degradation for limited periods of time, samples are optimally kept as cold as possible (if available, dry LN as provided in a dry shipper is ideal).



An automated filtration method can be used with the sterivex filters (shown at left), though for this project samples may be processed manually.

This allows the filtration of water from several one liter bottles at a time (using a vacuum pump) onto several sterivex filters. The sterivex filters can be used to filter up to 3L for very oligotrophic water.

Algal Collections

Lead Scientist: Rebecca Most, Peter Vroom
Target Habitat: Fore Reef, Back Reef, Reef Crest, Lagoon Patch Reef, La Perouse, Arc shell reefs, Acropora areas, Halimeda Fields
Target Organisms: macro, turf, coralline; macrofauna and mesofauna

A significant goal of algal surveys is to qualitatively describe the algal community and prepare a comprehensive species list for each site, specifically targeting lesser known species. Numerous species of algae unknown to science are frequently being described from Pacific Islands. Few algal experts have visited islands within the Hawaiian Islands National Wildlife Refuge, and the possibility of describing new species (thus increasing our understanding of biodiversity) is great. Working at depths of 0 to 30 m at the target habitats, a gallon-sized bag of algal samples (including red, brown, and green macro- and turf algae, and crustose coralline red algae) will be collected at each site and brought back to the ship for identification and analysis. Along with the hand collection of both macro and turf algae, crustose coralline algae will be collected using a small chisel to remove pieces of algae. No pieces of crustose coralline algae larger than 1" x 1" will be collected. Samples will initially be processed by Dr. Alison Sherwood's lab at the University of Hawaii, for molecular barcoding analysis to determine genetic diversity of the Hawaiian algal flora. Once processed, these samples will be placed in Bishop Museum. Detailed microscopic analysis and the placement of holotype specimens in internationally accepted herbaria are a necessary part of this process. An understanding of algal species ranges and

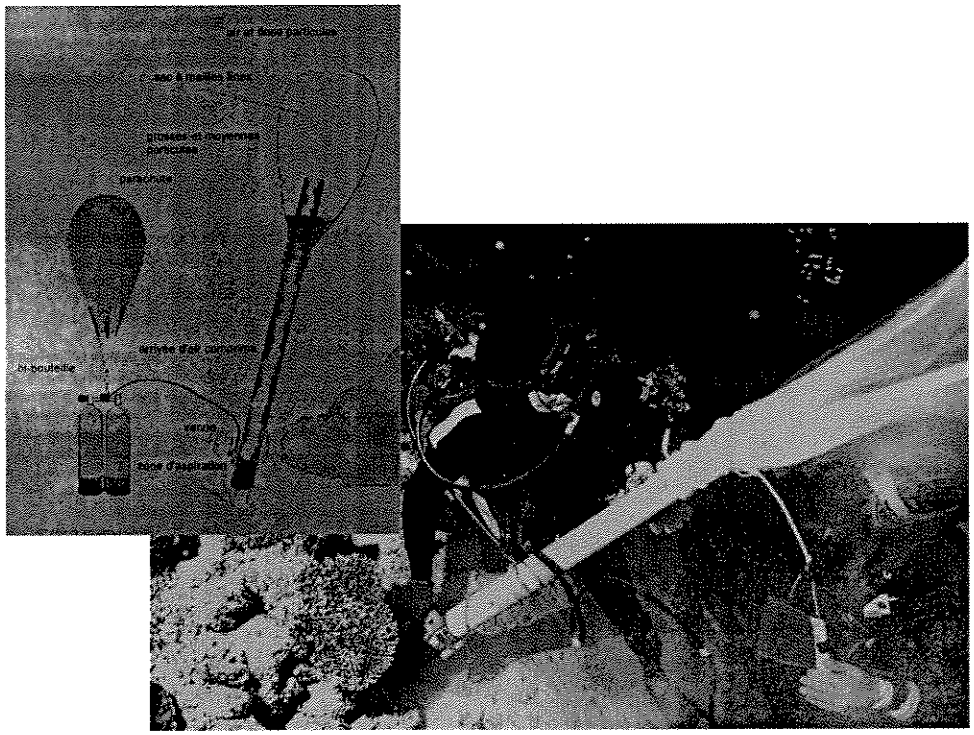
genetic similarity across Pacific Islands will enable biogeographic hypotheses to be formulated and provide information for marine dispersal mechanism useful to biologists in many different disciplines.

A major component of reef fauna lives on the surfaces and in the interstices of marine algae. Algae serve as nursery habitats for the juveniles of some macrofauna, and shelter mesofauna occurring exclusively on plants. Although algal associates can dramatically affect the ecology of their host plants and are an important link in the reef food chain, their diversity is poorly documented. The associates comprise complex communities, and constituent species may occur solely on particular groups of algae or on single host species. Although some algae-dwellers can be collected in situ, many sessile and highly active species are best sampled using an extraction technique analogous to that described for rubble. Clumps of algae approximately 4 liters in volume are removed from the substrate underwater, quickly sealed in plastic containers, and brought to the surface by divers. They are sorted and picked to remove larger and more obvious animals. Then, small chunks of algae are vigorously stirred in containers of seawater and quickly removed, so that dislodged animals can be picked from the residue and sieved from the supernatant water. The process is repeated, after which the algae may be returned to reef. The displacement volume and weight of algal samples can be measured, allowing for quantitative census of associated organisms.

Suction

Lead Scientist: Russell Brainard
Target Habitat: Fore Reef, Back Reef, Reef Crest, Lagoon Patch Reef
Target Organisms: Cryptic Epifauna

Suction sampling is a small-scale, objective procedure to collect baseline information, particularly on biodiversity, in a given area. A vacuum-type device will be used to suction samples in an area to obtain 'whole community' and potential key species information. This type of sampling involves lifting small organisms from exposed hard bottoms through suction generated by compressed air into a 2-4 inch diameter pipe. The gentle current created lifts small, mobile organisms into the pipe, capturing them in a mesh bag tied to the end of the pipe. Suction sampling has been used extensively in benthic ecology and fisheries (e.g., Brett, 1964; Hiscock & Hoare, 1973; Keegan & Konnecker, 1973). Recently the method has been employed very successfully in large-scale biodiversity inventory efforts (Bouchet et al. 2002). Suction sampling is the most effective method for surveying small or cryptic mobile invertebrates from exposed hard bottoms. This method will be used at two stations per habitat listed above, with three replicates per station.



Suction/Vacuum, Bouchet 2002.

Collections for Cryptofauna Analysis

Target Habitat: Forereef, Reef Crest, Back Reef **Target**
Organisms: Cryptic epifauna

Pocillopora sp. rubble will be collected to look for cryptofauna. A total of 10 rubble *Pocillopora sp.* will be collected over the course of the cruise, the invertebrates will be extracted in the ship-board laboratory and the rubble returned to the water. Each invertebrate organism will be preserved in 95% ethanol. The organism's associated data will be recorded: collector, taxonomic confirmation, date, georeference coordinates, picture etc. DNA will be extracted using commercial kits. Mitochondrial cytochrome c oxidase subunit I, 5' segment (COI-5') will be amplified and sequenced. The sequences will allow identification of previously described species, biodiversity information on invertebrates living in this environment and will be used in barcoding studies to help future researchers identify taxonomically challenging taxa. Barcode sequences will be submitted to the Barcode of Life Initiative and GenBank and the results will also be submitted to the Ocean Biogeographic Information System (OBIS).

Scoop

Lead Scientist: Russell Brainard, Gustav Paulay
Target Habitat: Lagoonal sand
Target Organisms: Macrofauna, Infauna and Epifauna

The Scoop is designed to target macrofauna, infaunal and epifaunal organisms in deeper, flat sand areas, approximately 100 meters in depth. The "scoop" would be towed up to 500-1000 m2, 1-2 times per day, time permitting. The scoop will be supported by the ship using 180-200 fathoms cable attached to a winch or pot hauler. It will pick up sand, rubble, and animals. It has a small mouth less than 100cm in width and 50cm in height, with a bag hanging back a few feet.

Vita
Russell Eugene Brainard

EDUCATION:

Ph.D. (Physical Oceanography)	1994	Naval Postgraduate School
Certificate (Project Management)	1993	University of Washington
M.S. (Oceanography)	1986	Naval Postgraduate School
B.S. (Marine Science)	1981	Texas A&M University

EMPLOYMENT:

Supervisory Oceanographer
Chief, Coral Reef Ecosystem Division
Pacific Islands Fisheries Science Center
National Marine Fisheries Service, National Oceanic and Atmospheric Administration (NOAA)
1125B Ala Moana Boulevard, Honolulu, Hawaii 96814
(808) 983-3737; (808) 983-3730 fax Rusty.Brainard@noaa.gov http://www.pifsc.noaa.gov/crd/

POSITIONS HELD:

2005-present	Co-PI CoML Census of Coral Reef Ecosystems (CReefs) Project
2005- present	Adjunct faculty, Department of Oceanography, University of Hawaii
2003-2004	Chair, Ecosystem Science Work Grp, NOAA Coral Reef Conservation Program
2002-present	Supervisory Oceanographer, Chief - Coral Reef Ecosystem Division, PIFSC – NOAA; PI – 12 multi-disciplinary projects - NOAA Coral Reef Program
2001-present	PI - Ocean Atlas Project, Pelagic Fisheries Research Program
2001-present	PI - Multi-agency NWHI Marine Debris Removal Project
2001-2004	Co-investigator - GhostNet Project, NASA funded
1998-2003	PI - Bigeye Tuna Oceanography Project, Pelagic Fisheries Research Program
1997-2002	Co-PI - Hawaiian Ocean Mixing Experiment, National Science Foundation
1998-2001	PI - Coral Reef Ecosystem Research Program, NOAA – Honolulu Laboratory
1981-2002	NOAA Commissioned Officer, Retired April 1, 2002 as Commander
1997-2001	Scientific Research Program Coordinator; Honolulu Laboratory
1994-1997	Commanding Officer, NOAA Ship *Townsend Cromwell*, Honolulu, HI
1992-1992	Master, R/V *Karluk*, Southeast Alaska
1990-1994	Physical Oceanographer, NOAA Pacific Marine Environmental Laboratory
1989-1990	Graduate Student, Naval Postgraduate School, Monterey, CA
1987-1989	Operations Officer, NOAA Ship *Townsend Cromwell*, Honolulu, HI
1984-1987	Res Oceanographer, NOAA Pacific Fisheries Environmental Grp, Monterey, CA
1982-1984	Station Chief – NOAA GMCC South Pole Observatory, Antarctica
1981-1982	Navigation Officer, NOAA Ship *Discoverer*, Seattle, WA

PROFESSIONAL SOCIETIES:

2003-present	International Society for Reef Studies
1986-present	American Geophysical Union - Life Member
1988-present	The Oceanography Society
1991-present	American Meteorological Society
1999-2003	Hawaii Academy of Science - Treasurer (1999-2001)

PRESENT RESEARCH ACTIVITIES:

1999-present	A comprehensive program to assess, monitor, map, and protect coral reef ecosystems of the U.S. Pacific Islands, Lead P.I. (12 inter-related projects).
2005-present	Census of Marine Life Census of Coral Reef Ecosystems, co-PI.
2001-present	High Seas GhostNet, Driftnet Detection and Tracking in the North Pacific, co-PI.
2000-2004	Development of oceanographic atlases for pelagic and insular fisheries and resource management of the Pacific basin, Lead P.I..
1999-2004	The role of oceanography on aggregation and vulnerability of bigeye tuna in the Hawaii longline fishery using satellite, moored, and shipboard time series, P.I.
1999-2003	Analysis of historical shipboard acoustic Doppler current profiler measurements along the Hawaiian Ridge, Hawaiian Ocean Mixing Experiment (HOME), co-P.I.

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